ANVIK RIVER CHUM SALMON ESCAPEMENT STUDIES, 1997-1999

By

Richard S. Chapell

REGIONAL INFORMATION REPORT[1] NO. 3A01-12

Alaska Department of Fish and Game
Division of Commercial Fisheries, AYK Region
333 Raspberry Road
Anchorage, Alaska 99518-1599

December 2001

[1] The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without approval of the author or the Division of Commercial Fisheries.

AUTHOR

Richard S. Chapell is a Fishery Biologist for the Alaska Department of Fish and Game, Division of Commercial Fisheries, 333 Raspberry Road, Anchorage, AK 99518.

ACKNOWLEDGMENTS

Lee McKinley, Marianne Profita, Alden Walker, Richard Driscoll, Eric Holm, and Kristine Neilsen collected much of the data presented in this report. Dan Huttunen and Gene Sandone provided critical review of this report.

OEO/ADA STATEMENT

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF APPENDICES

LIST OF APPENDICES (Continued)

ABSTRACT

The Anvik River sonar project has used side-looking sonar from late June until late July of each year since 1979 to estimate the passage of summer chum salmon *Oncorhynchus keta*. In 1997, an estimated 609,118 chum salmon passed the sonar site, exceeding the Anvik River minimum escapement objective of 500,000 fish. Passage estimates of 469,547 fish in 1998 and 441,305 chum salmon in 1999 failed to meet the minimum escapement objective. The timing of the 1997 chum salmon run was early, with quartile passage dates 2 to 4 days earlier than the long-term mean dates, based on 1979-1985 and 1987-1999 data. The 1998 quartile passage dates were 2 to 3 days later, and the 1999 quartile passage dates were 3 to 4 days later than the long-term mean dates.

Between 92% and 99% of sonar estimates occurred in the nearshore half of the sonar counting range of each bank throughout the 1997, 1998 and 1999 seasons, except for the last passage quartile of 1999, when 46% of sonar estimates were distributed in the offshore half of the counting range of the left bank sonar system. The predominant nearshore migration pattern of chum salmon, accuracy of sonar estimates, and species composition of passing fish were verified by periodic paired acoustic and visual tower counts.

A consistent diel pattern of the chum salmon migration was observed in all years from 1997 through 1999. Chum salmon passed the sonar site at the highest hourly rates during the darkest hours of the day, with an average of 26% of sonar estimates occurring in the 5-hr period between 21:00 and 02:00 hours in all three years.

Based upon age, sex, length samples collected by beach seine, the annual sex ratios of the chum salmon escapements ranged from 54% females in 1997 and 1988 to 58% females from in 1999. In all three years, the proportion of females increased as the run progressed.

Age-4 and age-5 fish combined comprised 98% to 99% of annual chum salmon samples from 1997 through 1999. In 1997 and 1999, age-5 fish were the dominant age class with 54% and 61% of the samples, respectively. The 1998 chum salmon run was distinguished by dominance of age-4 fish, which comprised 80% of the samples. In all three years, the proportion of age-4 fish increased while the age-5 proportion decreased over the course of the run.

KEY WORDS: Salmon, Anvik, catch, escapement, Yukon

INTRODUCTION

Two distinct runs of chum salmon *Oncorhynchus keta*, summer and fall, spawn in the Yukon River drainage. All the chum salmon that spawn in the Anvik River drainage are summer chum salmon. The Anvik River, which empties into the Yukon River at river kilometer (rkm) 512 (Figure 1), is the largest single producer of summer chum salmon in the Yukon River drainage (Bergstrom et al. 1999). Other known major spawning populations occur in other tributaries of the Yukon River such as the Andreafsky (rkm 167), Rodo (rkm 719), Nulato (rkm 777), Melozitna (rkm 938), and Tozitna Rivers (rkm 1,096), in tributaries to the Koyukuk River (rkm 817) such as the Gisasa (rkm 907) and Hogatza (rkm 1,255) Rivers, and in tributaries to the Tanana River (rkm 1,118) such as the Chena (rkm 1,480), and Salcha (rkm 1,553) Rivers (Figure 1). Summer chum salmon also spawn in lesser numbers in many other Yukon River tributaries. Chinook *O. tshawytscha* and pink *O. gorbuscha* salmon occur in the Anvik River coincidentally with summer chum salmon. Coho salmon *O. kisutch* spawn in the Anvik River drainage later during the fall.

Harvest of Anvik River Salmon

Commercial and subsistence harvests of Anvik River chum salmon occur throughout the mainstem Yukon River from the coast of the delta to the mouth of the Anvik River, and since 1994 within the first 19 rkm of the Anvik River. This section of river includes Lower Yukon Area Districts 1, 2, and 3, and the extreme lower portion of Subdistrict 4-A in the Upper Yukon Area (Figure 1). The legal fishing gear for salmon is set and drift gillnets in Districts 1-3, set gillnets and fish wheels in Subdistrict 4-A, and hand-operated seines, set gillnets, fish wheels in the Anvik River Management Area (ARMA). Most of the effort and harvest on the Anvik River stock occurs in Districts 1 and 2, and in the lower portion of Subdistrict 4-A below the confluence of the Anvik and Yukon Rivers. Whereas summer chum salmon taken commercially in Districts 1, 2, and 3 are sold in the round, salmon roe is the chief commercial product from the Subdistrict 4-A and the ARMA fisheries. Whole chum salmon are usually not bought in Subdistrict 4-A or the ARMA because of poor flesh quality and greater distance from the market. Subsistence fisheries in Districts 1, 2, and 3 take summer chum salmon primarily for human consumption. Subsistence harvest of summer chum salmon in Subdistrict 4-A is primarily for sled dog food.

Stocks other than the Anvik River stock support commercial and subsistence summer chum salmon fisheries in the remainder of District 4 and in District 6. Few summer chum salmon are harvested in District 5 because of the lack of spawning populations in that portion of the drainage.

In the Lower Yukon area, run timing of chinook and summer chum salmon greatly overlap from river-ice breakup through early July. During this time, commercial fisheries in the Lower Yukon area have traditionally targeted chinook salmon, while Subdistrict 4-A and ARMA commercial fisheries have targeted summer chum salmon. In the Lower Yukon area, large-mesh gillnets (stretch mesh greater than 15.2 cm) have been employed to harvest chinook salmon, with an incidental

harvest of summer chum salmon that is small in relation to summer chum salmon run sizes. Prior to the 1985 season, the Alaska Board of Fisheries (BOF), in order to allow directed harvests of summer chum salmon in the Lower Yukon, adopted regulations allowing fishing periods restricted to small-mesh (15.2 cm maximum stretch mesh) gillnets during the chinook salmon season provided that (1) the summer chum salmon run was of sufficient size to support additional exploitation, and (2) the incidental harvest of chinook salmon during these small-mesh fishing periods did not adversely affect conservation of that species.

Strong runs resulted in record commercial harvests of 1,620,269 summer chum salmon in 1988 and 1,456,928 chum in 1989 (Bergstrom et al. 1992). Distribution of the summer chum salmon catch among districts reflected stock distribution, market demand and scheduled fishing time. Increased market demand prompted allocation disputes between fishermen in different districts. In February 1990, the BOF established a guideline harvest range of 400,000 to 1,200,000 summer chum salmon for the entire Yukon River, allocated by district and subdistrict based on the average harvests of the previous 15 years (ADF&G 1990).

Anvik River summer chum salmon escapements from 1979 to 1993 exceeded the present minimum escapement goal of 500,000 salmon by an average of 233,000 salmon. To allow commercial exploitation of surplus escapements to the Anvik River, the BOF in March 1994 adopted the Anvik River chum salmon fishery management plan, allowing a commercial harvest of summer chum salmon in the terminal ARMA (ADF&G 1994). In 1996, the BOF established a harvest limit of 100,000 pounds of chum salmon roe for the ARMA (JTC 1996).

Stock Identification Studies

Several stock identification studies have been conducted on Yukon River chum salmon. The first was a small-scale investigation using scale pattern analysis, conducted by the Alaska Department of Fish and Game (ADF&G). Although results of this pilot study indicated that while separation between the summer and fall chum salmon stocks by scale pattern analysis was probably feasible, separation among summer chum salmon stocks or among fall chum salmon stocks was not (Wilcock 1988).

A more recent stock identification study (Wilmot et al. 1992) reported success in separating Yukon River chum salmon stocks using protein electrophoresis techniques. This study was initiated in 1987 by the United States Fish and Wildlife Service (USFWS) and continued through the 1991 season. Preliminary results indicated that among all represented Yukon River chum salmon stocks of the Yukon River, two major groups were apparent, a summer-run group and a fall-run group. These investigators also reported that within the summer-run group, two major subdivisions were evident, those of the lower river below rkm 800 and those of the mid-river (rkm 800-1,150). Wilmot (ibid.) also reported that estimated stock compositions of samples collected from District 1 commercial and test net fisheries during 1987 to 1990 indicated that the lower river summer-run chum salmon stocks contributed 75-100% to the catch until mid-July.

During the 1987 and 1988 field seasons, chum salmon genetic stock identification (GSI) collections were obtained at the mainstem Anvik River sonar site. Interestingly, these two collections were significantly different genetically (Wilmot et al. 1992). Although the collection obtained in 1987 was genetically similar to the lower river summer-run group, the collection obtained in 1988 was reported to be a separate group within the summer-run group and genetically distinct from the lower and mid-river groups. The investigators speculated that because the Anvik River is a large, productive river system and probably supports numerous spawning stocks, the mainstem collections at the sonar site in 1987 and 1988 most likely included different combinations of genetically distinct stocks. More recent GSI studies on chum salmon tributary populations within the Anvik River confirmed that there are genetically distinct populations within the Anvik River chum salmon stock (Crane et al. 1994).

In 1999, ADF&G genetics staff began collecting GSI samples from chum salmon at the Pilot Station sonar project site for use in a study to determine the variation in entry timing of summer- and fall-run chum salmon (JTC 1999). The distinction currently used for management purposes is that all chum salmon entering the Yukon River through July 15 are considered to be summer chum salmon, and those entering the river after July 15 are considered to be fall chum salmon.

Escapement Assessment

Historic comprehensive escapement assessment studies have been conducted on only a few selected spawning streams for the summer runs of chum salmon in the Yukon River drainage. ADF&G initiated summer chum salmon research on the Anvik River in 1972 and on the East Fork Andreafsky and Melozitna Rivers in 1981. The Anvik River project has been operated in various forms each year since 1972. Because of budget restrictions, the Melozitna River project was discontinued in 1984, and research on the Andreafsky River was discontinued for a time in 1989.

Since 1993, technicians count chinook and summer chum salmon escapements to the Chena and Salcha Rivers in the Tanana River drainage. These projects were operated by the Sport Fish Division of ADF&G, with late season funding contributed by the Division of Commercial Fisheries. Since 1994, the USFWS has operated salmon counting weirs on the East Fork Andreafsky and Gisasa Rivers. Chinook and summer chum salmon counting towers have been operated each year since 1994 on Kaltag Creek (rkm 725), the mainstem Nulato River (rkm 787) and Clear Creek (rkm 1,259) in the Hogatza-Koyukuk River drainage. The Kaltag Creek counting tower project has been operated by the city of Kaltag and funded primarily by the Alaska Cooperative Extension 4-H Program and the Bering Sea Fishermen's Association (BSFA). The Nulato River counting tower project has been operated by the Nulato Tribal Council (NTC) and funded by BSFA and ADF&G. The Clear Creek counting tower project has been funded and operated by the Tanana Chiefs Conference (TCC).

Study Area

The Anvik River originates at an elevation of 400 m and flows in a southerly direction approximately 200 km to its mouth at rkm 512 of the Yukon River. It is a narrow runoff stream with a substrate mainly of gravel and cobble. Bedrock is exposed in some of the upper reaches. The Yellow River (Figure 2) is a major tributary of the Anvik drainage and is located approximately 100 km upstream from the mouth of the Anvik River. Downstream from the confluence of the Yellow River, the Anvik River changes from a moderate gradient system to a low gradient system meandering through a broad flood plain. Turbid waters from the Yellow River greatly reduce the water clarity of the Anvik River below their confluence. Numerous oxbows, old channel cutoffs and sloughs are found throughout the lower Anvik River.

Anvik River salmon escapements were partially estimated from visual counts made at two counting tower sites from 1972 to 1979 above the confluence of the Anvik and Yellow Rivers (Figure 2). A site 9 km above the Yellow River on the mainstem Anvik River was used from 1972 to 1975 (Lebida 1973; Trasky 1974, 1976; Mauney 1977). From 1976 to 1979 a site on the mainstem Anvik River near the confluence of Robinhood Creek and the Anvik River was used (Figure 2; Mauney 1979, 1980; Mauney and Geiger 1977). Other than in 1974, aerial surveys were flown each year in fixed-wing aircraft to estimate salmon abundance below the tower site. High and turbid water often limited observation from counting towers and aerial surveys.

The Electrodynamics Division of the Bendix Corporation[2] developed a side-looking sonar device during the 1970s capable of detecting migrating salmon along the banks of streams. A pilot study using side-looking sonar to estimate chum salmon escapement to the Anvik River was conducted in 1979. Results of this study indicated that sonar-based estimation of chum salmon escapements to the Anvik River was superior to the counting tower method (Mauney and Buklis 1980). Thereafter, in 1980, sonar replaced the tower counting method for estimating chum salmon escapement.

Since 1979, the Anvik River sonar project has been located approximately 76 km upstream of the confluence of the Anvik and Yukon Rivers, 5 km below Theodore Creek (Figure 2) in Section 35, Township 31 North, Range 61 West, Seward Meridian. Aerial survey data indicate that chum salmon spawning activity is located primarily upstream of the sonar site. The land is public, managed by BLM, and presently unclassified. Project results for escapement studies using sonar technology on the Anvik River from 1979 to 1995 have been reported by Mauney and Buklis (1980), Buklis (1981, 1982, 1983, 1984a, 1984b, 1985, 1986, 1987), Sandone (1989, 1990a, 1990b, 1993, 1994a, 1994b, 1995, 1996), and Fair (1997). This report presents results of the Anvik River chum salmon escapement project for the 1997, 1998 and 1999 field seasons.

[2]Use of a company's name does not constitute endorsement.

Objectives

Because much of the commercial and subsistence harvest of summer chum salmon typically occurs in the Yukon River drainage upstream from the mouth of the Anvik River, it is important to accurately assess the strength of the upriver run so that escapement and harvest needs can be met. The information derived from the Anvik River sonar project has been used in conjunction with Yukon River sonar passage estimates, and subsistence and commercial harvest data in some recent years, to assess the strength of the Yukon River summer chum salmon run above the mouth of the Anvik River. The timely and accurate reporting of information from the Anvik River sonar project is a critical to Yukon River summer chum salmon management. The purpose of this project is to monitor the escapement of summer chum salmon to the Anvik River.

The two primary objectives of this project are to:

1. estimate the daily summer chum salmon escapement passing the Anvik River sonar site; and

2. estimate the age and sex composition of the summer chum salmon spawning escapements.

METHODS

Sonar Deployment and Operation

A sonar transceiver has been installed and operated on each bank of the Anvik River near Theodore Creek (Figure 2) each year since 1979. The sonar system operates by transmitting sound waves outward from shore along the riverbed. Valid echoes from salmon passing through the sonar beam are reflected back to the transducer and filtered and processed in the transceiver. Echoes are counted and combined to estimate salmon abundance. Criteria for strength and frequency of the echoes are designed to estimate salmon passage and minimize debris counts.

During the 1997 through 1999 seasons, 1981-model sonar "counters" (transceivers) were deployed and operated according to guidelines described by Bendix Corporation (1981) on each bank of the Anvik River to estimate chum salmon passage. Sonar was operated without the prescribed artificial aluminum substrate throughout the season. This practice of operating without an artificial substrate was first employed on the Anvik River in 1986 (Buklis 1986). The right (west) and left (east) bank sites used in previous years were probed to locate uniform river bottom gradients that would provide optimum linear surfaces for ensonification. Each sonar transducer was mounted on a rectangular aluminum frame, which was mounted to a pipe configuration that easily allowed the transducer to be moved during aiming without affecting stability. Sandbags were placed on top of the pipe

housing to ensure stability. Sonic waves from each transducer were aimed perpendicular to the current and transducers were offset to prevent interference (cross-talk) between opposite banks. To prevent fish passage inshore of the transducer, weirs constructed of T-stakes and rectangular mesh fencing were installed downstream of the transducer at an oblique angle from shore leading upstream toward mid-river and extending from shore to approximately 1 m beyond the transducer. Counting towers of aluminum scaffolding material approximately 3 m in height were placed upstream of the transducers on each bank for visual observation of salmon when water conditions permitted. Transducers and weirs were moved inshore or offshore as required by fluctuating water levels.

Transducers were aimed and listening ranges adjusted so that echoes resulting from the stream bottom or surface interface did not register as 'counts' by the sonar electronics. Sensitivity, as measured in voltage from peak to peak, was adjusted to the highest level without registering false 'counts'. This level was usually the maximum possible for the equipment. Sonar ensonification ranges were adjusted in response to changing river conditions. The 1981-model counter has a maximum range of 30 m. Because of the conical shape of the sonar beam, its width and height increase with distance from the transducer. The ensonified zone of the river encompassed approximately the bottom half of the vertical water column within the counting range throughout operations.

The 1981-model counters used on the Anvik River sonar project divided the ensonification range into 16 sectors of equal length. Sector length was dependent on the total ensonification range. In all subsequent analyses, sectors were consecutively numbered from the right to left bank, with the right and left banks defined as viewed by an observer facing downstream. Therefore, sectors 1-16 were associated with the right bank counter, and sectors 17-32 were associated with the left bank counter. Sector numbers 1 and 32 corresponded to the nearshore sectors on the right and left banks.

The right bank transducer was located along a gradually sloping gravel bar on the inside of a bend in the river, approximately 100 m upstream from the field campsite. The left bank transducer was typically located 3 m upstream of the right bank transducer, on the outside of same bend in the river. The riverbed slopes more steeply from the left bank toward the thalweg than it does from the right bank. Both right and left bank transducers were typically placed in water 0.7 m deep.

In most years, some salmon passed the sonar site prior to and after the cessation of sonar operations. However, these numbers probably comprised only a small fraction of the total run. Salmon abundance indicators from monitoring projects downstream on the mainstem Yukon River were used to plan the Anvik River sonar project start dates. The criteria for terminating sonar sampling were daily chum salmon passage estimates of less than one percent of the season's total passage estimate for three successive days.

Sonar Calibration and Sampling

Each sonar transceiver was 'calibrated' at least four times daily by observing passing fish targets using an oscilloscope. In this and past studies using the Bendix system, the term 'calibrate' refers to adjusting the ping rate to account for variable swimming speeds. Fish passing through the sonar beam produce a distinctive oscilloscope trace that resembles a spike. During each calibration period, the number of fish detected by an operator using an oscilloscope was compared to estimates automatically recorded by the sonar electronics. The fish velocity control setting, which controls the sonar counter's ping rate, was adjusted immediately after a calibration if the oscilloscope:sonar estimate ratio varied from 1.0 by 0.15 or more. The existing fish velocity setting was multiplied by this ratio to obtain a new setting. If adjustments were made to the sonar unit, the change was documented in the calibration log, and an additional calibration was made to ensure that the new oscilloscope:sonar estimate ratio was within accepted limits and to initialize the counting period. Each calibration lasted for at least 15 minutes or until 100 fish were estimated by the observer, whichever came first.

Attempts were also made to visually count passing fish from 3 m counting towers during sonar calibration times as a further check on sonar accuracy and to train personnel in oscilloscope monitoring. Observers wore polarized sunglasses to reduce water surface glare. Observations of fish were sometimes hampered by glare, which resulted from overcast skies and reflection of the sun off the water. At times, low light conditions at night and occasional turbid water conditions also hampered tower observations.

Four daily calibration times were deemed adequate to monitor the diel timing pattern of the salmon migration (Sandone 1996). Calibrations were normally conducted during 0600, 1200, 1800, and 2400 hours. Occasionally, calibration times deviated from prescribed times. Counting periods were defined by each calibration event. An adjustment factor, specific to each counting period and to each bank was calculated using the following formula:

$$A_{b,n} = \frac{OC_{b,n}}{SC_{b,n}} \qquad 1$$

where A = periodic adjustment factor,
b = right or left bank,
n = counting period (0000-0600, 0600-1200, 1200-1800, or 1800-2400),
OC = oscilloscope counts, and
SC = sonar counts.

Adjusted passage estimates were calculated by multiplying each calibration period's adjustment factor by the unadjusted sonar estimates for each hour within the calibration period for each bank. Adjusted estimates were further corrected for missing data and corrected hourly. Estimates were calculated and totaled for each day and bank using a spreadsheet program on a desktop computer. The resulting corrected sonar estimates for each hour within a day were summed, yielding the estimated chum salmon passage for that day for that bank. The daily passage of salmon for the whole river was determined by summing the daily bank-specific estimates. Daily adjustment or

correction factors for each bank and for both banks combined were calculated by dividing the corrected daily estimates by the raw sonar estimates. Raw sector estimates for each day were corrected using the overall daily correction factor. Corrected hourly and sector estimates were used to describe the temporal and spatial distribution of the chum salmon run.

Sonar counters do not distinguish between species of fish. Aerial surveys were used to obtain a separate escapement estimate for chinook salmon. These yearly estimates were not subtracted from the chum salmon sonar estimates because chinook salmon abundance is low relative to chum salmon abundance.

No estimate of pink salmon passage was made in 1997 or 1999 because pink salmon abundance in the Anvik River has historically been very low during odd-numbered years. Similar to other even-numbered years, pink salmon in 1998 were observed at the sonar site beginning in early July. After pink salmon were observed in significant numbers, at least two tower observations were conducted from each bank during each 24-hour period to estimate the proportion of pink and chum salmon passing the sonar site on a daily basis. This daily proportion was applied to the adjusted daily total salmon passage estimate to yield a daily estimate of pink salmon passage, which was then subtracted from total salmon passage to yield the daily chum salmon passage estimate.

Hourly sector estimates that were lacking as a result of debris, printer malfunction, or weather-related disruptions of sonar operations were calculated by averaging sector estimates for the hour before and after the missing data. When hourly data were not recorded for more than 3 hours and less than 12 hours within one day, the corrected total daily estimate for that day was calculated by dividing the corrected partial daily value by the mean proportion of corrected estimates for the corresponding hours for the first day before and after the day in question with complete data collection. When hourly data were not recorded for 12 hours or more within a day, the passage for that day was calculated by averaging the daily estimates for the first day before and after the day in question with complete data collection. No attempt was made to recreate the spatial or temporal distribution of estimates made for time periods with no recorded data for more than 2 hours.

When conditions forced a suspension of sonar sampling on only one bank for more than one day, that bank's daily estimates were calculated from salmon passage on the opposite bank in conjunction with bank-specific passage proportion based on all days during the season with full counts from both banks. When sampling was suspended on both banks for an entire day, the daily total salmon passage estimate was made using straight-line interpolation between the previous day's and the following day's whole river corrected estimates.

Age-Sex-Length Sampling

Temporal strata, used to characterize the age and sex composition of the chum salmon escapement, were defined as quartiles using the dates on which 25%, 50%, 75%, and 100% of the total run had passed the sonar site. These quartile sampling strata were determined pre-season based on historical run timing data; they represent an attempt to sample the escapement for age-sex-length (ASL)

information in relative proportion to the total run. In 1997, these strata were defined as: 15 June-3 July; 4-8 July; 9-13 July; and 14-27 July, and the dates were not adjusted in-season. In 1998 and 1999, the strata were defined pre-season as: 17-30 June; 1-7 July; 8-14 July; and 15-30 July. The dates were adjusted during the 1998 and 1999 seasons to reflect actual chum salmon run timing based on data provided by the Yukon River sonar and other salmon assessment projects.

To meet region-wide standards for the sample size needed to describe a salmon population, the seasonal ASL sample goal was 640 chum salmon, with a minimum of 160 chum salmon samples collected during each temporal stratum (Bromaghin 1993). The sample size goals are based on accuracy (d) and precision (α) objectives of $d = 0.10$ and $\alpha = 0.05$, assuming three age categories (age-4, age 5, and other), with a rejection rate of 15%. The beach seining goal for chinook salmon was to sample all fish captured while pursuing the chum salmon sampling goals.

A beach seine (31 m long, 66 meshes deep, 6.35-cm mesh) was set approximately 100 m above the sonar site to capture chum salmon to collect ASL data. All resident fresh-water fish captured were tallied by species and released. Pink salmon were counted by sex and released. Chum salmon were placed in a holding pen and each was noted for sex, measured to the nearest 5 mm from mid-eye to fork-of-tail, and one scale was taken for age determination. Where possible, scales were removed from an area posterior to the base of the dorsal fin and above the lateral line on the left side of the fish (Clutter and Whitesel 1956). The adipose fin was clipped on each sampled chum salmon to prevent resampling. If any chinook salmon were caught, they were sampled using the same methods, except that three scale samples were taken from each fish. A separate project to characterize the age and sex composition of Anvik River chinook salmon involved collecting ASL samples from chinook salmon carcasses immediately after the sonar program terminated.

Climatological and Hydrologic Sampling

A river bottom profile was determined by measuring water depth at 3-m intervals from established headpins across the width of the river by probing with a pole marked in 1-cm increments. Because the left bank sonar site was typically situated approximately 3 m upriver from the right bank site, one transect line between the sites served to describe the profiles.

Climatological and hydrologic data were collected at approximately 1800 hours each day at the campsite. Relative river depth was monitored by staff gauge marked in 0.3 cm (0.01 ft) increments. Change in water depth was presented as negative or positive increments from the initial reading of 0.0 cm. Water temperature was measured in degrees C near shore at a depth of approximately 0.5 m. Daily maximum and minimum air temperatures were recorded in degrees C. Subjective notes were kept in a log by the crew describing wind speed and direction, cloud cover and precipitation.

RESULTS AND DISCUSSION

River and Sonar Counting Conditions

Two sonar systems, one on each bank, were operated in 1997, 1998, and 1999 at approximately the same sites used from 1979 to 1996, with one exception: in 1998, due to high initial water levels, the right bank transducer was deployed approximately 100 m downstream from the right bank site used in all other years.

In 1997, right and left bank sonar system operations began on 19 June, the second earliest start-up date for this project (Table 1). After 21 June, the Anvik River water level dropped steadily for the rest of the season (Figure 3). The total drop was 41.8 cm (Appendix A.1). Shallow water and lack of turbidity throughout the season allowed excellent visual confirmation of sonar passage estimates and species apportionment. The right bank sonar system was operated until 23 July, when the water level dropped so low that the river was no longer wide enough to operate two sonar systems. The left bank sonar system was operated through 24 July.

The 1997 river depth profile data are not available. For the 1997 season, the average right bank sonar counting range was 15 m, and the average left bank counting range was 14 m.

Water levels fluctuated widely in 1998. The right bank sonar system began operation on 22 June when the water level was very high relative to other years. Debris flowing in the river delayed deployment of the left bank sonar system until 25 June. The water level dropped 43.3 cm from 23 June to 6 July (Figure 4; Appendix A.2). Subsequent heavy rain resulted in a rapid 77.4 cm rise that crested on 10 July. High water and debris flow required the crew to suspend sonar sampling and move the sonar equipment to higher ground on 9 July. On 11 July, falling water levels allowed the crew to redeploy the right bank system, but continued debris flow prevented deployment of the left bank system until 15 July. The water dropped 92.9 cm from 10 July through 23 July. Right and left bank sonar systems were operated through midday on 24 July.

A depth transect, which used start and end points that were not at the water edges, measured the Anvik River width to be greater than 62 m on 6 July 1998 (Figure 4). On this day, just before the 7-10 July 1998 flood, the right bank transducer was more than 9 m from the right bank water edge and the sonar ensonified range was 13 m. The left bank transducer was more than 14 m from the left bank water edge, and the ensonified range was 22 m. The mean river height for the 1998 season was 15.3 cm higher than it was on 6 July (Appendix A.2), so the Anvik River was generally wider than 62 m. For the 1998 season, the average right bank sonar ensonified range was 14 m, and the average left bank ensonified range was 21 m.

In 1999, the right bank and left bank sonar systems were installed on 25 June and 26 June, respectively, at approximately the same sites used in 1997 and previous years. The first chum salmon were counted passing the sonar site on 27 June, the third latest date of first chum salmon passage in the 20 year history of the Anvik River sonar project (Table 1). The highest water level

was recorded on the first day of the project, after which it dropped 73.2 cm to its seasonal low point on 19 July (Figure 4; Appendix A.3). Both the left bank and right bank sonar systems operated continuously through 28 July, which is the second latest termination date for the project (Table 1).

On 26 June, at a relatively high water level for the 1999 season, a depth transect measured the Anvik River width at 72 m (Figure 3). Between the 1998 and 1999 seasons, the left bank profile at the sonar site developed a relatively flat 6-m wide shelf, starting at 9 m and extending to 15 m from the left water edge on the day of the transect. The mean river height for all sonar operation days in 1999 was 34.4 cm lower than on 26 June (Appendix A.3), so the river was, on average, much narrower than 72 m. For the 1999 season, the mean right bank sonar ensonified range was 16 m, and the mean left bank ensonified range was 14 m.

Except for two to four days during each of the 1997 to 1999 seasons, the daily water temperature at the sonar site was always bounded by the daily maximum and minimum air temperatures (Figure 5). Of the three seasons, 1997 had the highest mean water temperature, 15.3°C, and both the highest daily maximum, 29.5°C, and the lowest daily minimum, -1.0°C, air temperatures (Appendix A.1). The 1998 season experienced the coolest mean water temperature (12.3°C) and the narrowest range of air temperatures with a daily maximum of 25°C and a daily minimum of 4.5°C (Appendix A.2). During the 1999 season, the mean water temperature was 14.6°C, the maximum daily air temperature was 26°C, and the daily minimum air temperature was 0°C (Appendix A.3).

Escapement Estimates and Run Timing

The 1997 escapement estimate for the 36-day period from 19 June through 24 July was 609,118 chum salmon (Table 2), including estimates for missing sector/hourly counts and expansions for right bank passage on 23-24 July. The median day of passage was 3 July, and the central half of the run passed between 28 June and 10 July (Figure 6). Relative to historic timing, statistics based on 1979-1985 and 1987-1996 data, the 1997 chum run was early (Figure 7). The 1986 timing statistics are excluded from the historic mean because the project was terminated early for lack of funding. All quartile days in 1997 were two to four days earlier than the historic mean (Table 1). The duration of the middle 50% of the run was 12 days, which is two days longer than the historic mean. Daily passage between the first and third quartile days ranged from 13,524 to 38,613 chum salmon (Table 2).

The 1997 chum salmon entry pattern was somewhat protracted (Figure 6), with the peak passage of 38,613 chum salmon on 29 June (Table 2). Chum salmon passage was greatest during the 7-day period from 28 June to 4 July, centered around the second quartile of the run. During this period, 216,540 chum salmon, or 36% of the total escapement, passed the sonar site.

From 19 June through 23 July 1997 a total of 40.0 h of sonar calibrations were conducted at the right bank site (Appendix B.1). Right bank sonar:oscilloscope estimates averaged 1.10. From 20 July to the end of the 1997 season, spawning salmon were lingering in the beam of the right bank transducer and the water had become too shallow to move the transducer beyond the area of holding

fish. The fish velocity compensation was adjusted to the slowest setting (.999), but raw sonar estimates were still more than 15% higher than oscilloscope estimates. On 23 July, right bank sonar sampling was terminated at midday, and the remainder of the day's right bank passage was expanded from tower counts. On 24 July, right bank passage was expanded from the left bank sonar-based passage estimate, using the right:left bank passage ratio from 23 July. The left bank sonar system averaged 1.03 sonar:oscilloscope estimates during 36.1 h of calibration from 19 June–24 July.

A total of 1,097 chum salmon, 28 chinook salmon, and zero pink salmon were counted passing upstream during 6.3 h of visual counts done from the right bank tower in 1997. On the left bank, a total of 412 chum salmon, 3 chinook salmon and one pink salmon were counted passing upstream during 2.3 h of tower counts.

The 1998 escapement estimate for the 33-day period from 22 June through 24 July was 469,547 chum salmon (Table 3), including estimates for missing sector/hourly counts, as well as estimates for 9-14 July when sonar sampling was suspended on one or both banks as a result of high water. The right bank passage estimate for 10 July is the result of straight-line interpolation between 9 July and 11 July right bank estimates. The linear regression of left bank on right bank chum salmon estimates for all days in the 1998 season with sonar-based estimates for both banks yields the formula:

$$\textit{corrected left bank estimate} = 0.1043*(\textit{corrected right bank estimate}) + 1108. \qquad 2$$

This formula was used to estimate left bank chum salmon passage on 9-14 July from right bank daily chum salmon passage estimates. Beginning on 12 July on the right bank and 15 July on the left bank, daily pink salmon estimates were subtracted from corrected daily salmon estimates to yield daily chum salmon passage estimates.

The 1998 median chum salmon passage day was 9 July, and the central half of the run passed between 5 and 14 July (Figure 6). The 1998 chum salmon run was late relative to mean historic run timing data, based on 1979-1985 and 1987-1996 runs (Figure 7). The date of first chum salmon passage (22 June) was the same as the historic mean, but all of the 1998 quartile days were two to four days later than the mean duration (Table 1). The duration of the middle 50% of the run was nine days, which is one day less than the historic mean. Daily passage between the first and third quartile days ranged from 15,637 to 35,930 chum salmon.

The 1998 chum salmon entry pattern was weak and protracted (Figure 6). The peak passage occurred on 7 July, with 35,390 chum salmon (Table 3). Chum salmon passage was greatest during the 7-day period from 6 July through 12 July, which includes the median passage day. During this 7-day period 181,156 chum salmon, 39% of the total season escapement, passed the sonar site.

From 21 June–9 July and 11–24 July 1998, a total of 29.7 h of sonar calibrations were conducted at the right bank site (Appendix B.2). Right bank sonar:oscilloscope estimates averaged 1.02. At the left bank site, sonar:oscilloscope observations averaged 1.09 during 26.0 h of calibrations from 25 June–8 July and 15–24 July. A total of 3,776 chum salmon, 3 chinook salmon, and 1,748 pink

salmon were counted passing upstream during 10.4 h of visual counts done from the right bank tower. On the left bank, a total of 797 chum salmon, 3 chinook salmon, and 1,569 pink salmon were counted passing upstream during 6.25 h of tower counts.

The first pink salmon in 1998 was observed on 8 July stuck in the right bank weir. Because of high, turbid water, the first tower counts used to apportion sonar estimates between pink salmon and chum salmon were delayed until 12 July (Appendix B.2). The right bank pink salmon proportion was initially calculated from adjusted sonar estimates at 11% on 12 July, and peaked at 61% on 23 July (Figure 8). Left bank salmon passage estimates for 9-14 July were generated using data which had been corrected for pink salmon abundance, so these estimates can be considered to be all chum salmon (Table 3). Daily estimates of the pink salmon proportion of left bank salmon passage started at 69% of adjusted sonar estimates on 15 July, and peaked at 89% on 23 July. The daily pink salmon proportion of all passing salmon was always higher on the left bank than on the right bank, but the daily number of pink salmon passing was higher on the right bank on all but two days from 15 through 24 July (Figure 8). Daily pink salmon passage for the both banks combined reached two peaks in 1998: 21,363 fish on 20 July and 20,177 fish on 22 July. Although the pink salmon proportion of all salmon passage remained high, the total abundance of pink salmon appeared to be declining along with chum salmon abundance when sonar sampling was terminated on 24 July.

The 1999 escapement estimate for the 32-day period from 27 June through 28 July was 441,305 chum salmon (Table 4), including estimates for missing sector/hourly counts. The median passage day was 10 July, and the central half of the run passed between 6 and 16 July (Figure 6). The 1999 chum salmon run was later than historic mean run timing based on 1979-1985 and 1987-1996 data (Figure 7). The date of first chum salmon passage was 5 days later than the historic mean, and all of the 1999 quartile days were three to four days later than the mean (Table 1). The duration of the middle 50% of the run was nine days, one day less than the historic mean. Daily passage between the first and third quartile days ranged from 13,009 to 34,683 chum salmon.

The 1999 chum salmon entry pattern was weak and unimodal (Figure 6). The peak passage of 34,683 chum salmon occurred on 7 July (Table 4). In 1999, chum salmon passage was greatest during the 7-day period from 5 through 11 July, which includes the median passage day. During this 7-day period 44% of the total season escapement, 196,082 chum salmon, passed the sonar site.

From 27 June–28 July 1999, a total of 32.4 h of sonar calibration were conducted at the right bank site (Appendix B.3). Right bank sonar:oscilloscope estimates averaged 1.05. At the left bank site, sonar:oscilloscope estimates averaged 1.07 during 36.5 h of calibration from 27 June–28 July. A total of 1,027 chum salmon, 6 chinook salmon, and zero pink salmon were counted passing upstream during 6.0 h of visual counts done from the right bank tower. On the left bank, a total of 1,177 chum salmon, zero chinook salmon, and zero pink salmon were counted passing upstream during 10.6 h of tower counts.

As is typical for the Anvik River in odd-numbered years, only 1 pink salmon was observed during the 1997 season (Appendix B.1), and none were seen in 1999 (Appendix B.3), so no adjustments to chum salmon passage estimates were attempted.

Buklis (1982) expanded the season escapement estimates for 1972 through 1978, making it possible to compare earlier visual estimates to more recent annual sonar estimates (Figure 9). The 1997 chum salmon escapement estimate was 11% below the mean Anvik River escapement estimate of 682,000 fish, based on 1972-1996 data. The 1998 and 1999 escapement estimates were 31% and 35%, respectively, below the same mean. The 1997 escapement estimate exceeded by 22% the minimum escapement goal of 500,000 chum salmon past the Anvik River sonar project. The 1998 and 1999 escapements both failed to meet the minimum chum salmon spawning goal, achieving only 94% and 88% of that goal.

Spatial and Temporal Distribution

Buklis (1982) first reported a distinct diurnal salmon migration pattern during the 1981 season with a higher proportion of the migration passing the sonar site during the darker hours of the day. Similar diurnal patterns were reported from 1985 through 1996 (Buklis 1985, 1986, 1987; Sandone 1989, 1990a, 1990b, 1993, 1994a, 1994b, 1995, 1996; Fair 1997). The temporal distribution of right bank (Appendix C.1-C.3) and left bank (Appendix D.1-D.3) sonar estimates indicated a distinct diel pattern during the 1997, 1998, and 1999 seasons (Figure 10). Based on corrected estimates for days with full 24-h sonar-based estimates, 61% of corrected estimates in 1997 occurred during the 12 hours from 1800 to 0600 hours. In 1998, 57% of estimates were between 2100 and 0900 hours. In 1999, 60% of estimates fell between 2000 and 0800 hours.

Prior to 1997, in all but two years that sonar was used to estimate Anvik River chum salmon escapement, a majority of the escapement passage had been associated with the right bank (Mauney and Buklis 1980; Buklis 1981, 1982, 1983, 1984a, 1984b, 1985, 1986, 1987; Sandone 1989, 1990a, 1990b, 1993, 1994, 1994b, 1995, 1996; Fair 1997). In the two exceptional years 1992 and 1996, only 43% and 45%, respectively, of the total adjusted estimates were observed on the right bank (Sandone 1994a; Fair 1997). The shift to left bank was attributed to low water conditions that affected chum salmon migration patterns at the sonar site. The 1985-1996 average of chum salmon estimates passing along the right bank was 67%. In 1997, the Anvik River again experienced extremely low water conditions during the chum salmon migration, and only 39% of adjusted chum salmon estimates were from the right bank (Table 2). The 1998 and 1999 chum salmon migrations followed the dominant right bank orientation trend with 84% and 63%, respectively, of estimated chum salmon passing on the right bank (Tables 3, 4).

A fundamental assumption of the Anvik River Sonar project is that, because of the bank-oriented migration behavior of chum salmon, the two sonar systems based on opposite shores detect essentially all chum salmon passing the sonar site. In 1997 through 1999, this assumption was generally supported by the relative lack of passage estimates in the offshore sonar sectors, despite year-to-year variations in right and left bank preference (Figure 11), and by tower observations of spatial distribution. In 1997, 1998, and 1999, the sonar sectors in the nearshore half of the right bank counting range accumulated 98%, 99%, and 92%, respectively, of the annual right bank sonar estimates (Appendix E.1-E.3). On the left bank in all three years, the nearshore half of the sonar

counting range accumulated 97%, 99%, and 86%, respectively, of the annual left bank sonar estimates (Appendix F.1-F.3).

The relatively low (86%) nearshore passage on the left bank in 1999 can be traced to 13 days of the 32-day season when daily sector-specific estimates for the left bank sector 17, the furthest offshore, were the highest of all daily left bank sectors (Figure 12). This anomalous pattern occurred on four days between 28 June and 3 July, in the first passage quartile, and on nine days from 17 to 27 July, during the final quartile (Appendix F.3). These anomalous mid-river sonar estimates, which were confirmed by both visual and oscilloscope counts, suggested a minor trend in fish passage in the unensonified portion of the river during certain water conditions. The 1999 sonar crew observed that at low water levels, some chum salmon passed the site in deeper mid-river water, avoiding the shallow water area above a shelf near the left bank that formed between the 1998 and 1999 seasons (Figure 3).

During each season from 1979 to 1999, minor day-to-day shifts between sector estimates were probably caused by changes in placement and aiming of the transducer in response to fluctuating water levels, rather than by shifts in chum salmon migratory patterns.

Age and Sex Composition

In 1997, beach seine sets were made from 26 June to 24 July on 14 individual days. A total of 864 chum salmon were captured, of which 644 were sampled for ASL information (Appendix G.1). Sample sizes for the first through fourth passage quartile were 44, 137, 261, and 202 chum salmon, consecutively. Of those fish sampled for ASL data in each quartile, 36, 116, 234, and 188 had ageable scales. Because of the early run timing of chum salmon in 1997, the first and second quartiles were less well sampled, with fewer than the desired 138 ageable scales per stratum, while the third and fourth quartiles were sampled more heavily. Of the 644 chum salmon sampled for ASL data, 89% had ageable scales, more than the 85% expected rate.

In 1998, beach seine sets were made on 13 individual days from 26 June to 20 July. A total of 948 chum salmon were captured, of which 565 were sampled for ASL information (Appendix G.2). Sample sizes for the first through fourth 1998 passage quartiles were 155, 70, 97, and 243 chum salmon. High water disrupted beach seining efforts during the middle half of the run. Of those fish sampled for ASL data each quartile, 127, 58, 77, and 198 had ageable scales. The first, second, and third quartiles did not achieve sample size goals. Of the 565 chum salmon sampled for ASL data, 81% had ageable scales, below the 85% expected rate.

In 1999, beach seine sets were made from 4 to 20 July on 11 individual days. A total of 622 chum salmon were sampled for ASL data (Appendix G.3). Sample sizes for the first through fourth passage quartiles were 127, 163, 163, and 169 chum salmon. The timing of the ASL sampling effort closely matched the chum salmon run timing. Of those fish sampled each quartile, 81, 120, 132, and 129 had ageable scales, so all four quartiles had sample sizes smaller than the 138 desired. Of the season total of 622 chum salmon sampled for ASL data, 74% had ageable scales, well below the

85% expected rate. Scales that were determined "illegible" by the scale reader composed 15% of the samples collected.

The first three quartiles of 1997 were dominated by age-5 chum salmon, accounting for 72%, 66%, and 57% of the passage (Figure 13). Age-4 salmon dominated the final quartile, accounting for 56% of the passage. The overall age composition of the escapement, using temporal strata determined by the closest sample dates and weighted by escapement estimates, was 0.5% age-3, 43.7% age-4, 54.2% age-5, and 0.8% age-6 (Appendix H). The age-4 component of the run was lower and the age-5 component was higher than the median values for 1972-1996.

The 1998 escapement was exceptional in that age-4 chum salmon greatly dominated all quartiles, representing 66%, 79%, 95%, and 84% of the samples in the first through fourth quartiles (Figure 13). The overall age composition of the escapement, using temporal strata determined by the closest sample dates and weighted by escapement estimates was 0.0% age-3, 80.4% age-4, 18.3% age-5, and 1.3% age-6 (Appendix H). Only three of the twenty-five chum salmon escapements sampled from 1972 to 1996 were characterized by a larger proportion of age-4 fish.

The age composition of the 1999 chum salmon run was similar to the 1997 run in that age-5 chum salmon dominated the first through third quartiles, composing 80%, 58%, and 67% of the samples (Figure 13). The overall age composition of the 1999 escapement, using temporal strata determined by the closest sample dates and weighted by escapement estimates, was 0.0% age-3, 37.4% age-4, 61.3% age-5, and 1.3% age-6 (Appendix H). As was the case in 1997 the age-4 proportion of the 1999 run was lower and the age-5 component was higher than the median values for 1972-1996.

Typically, the age and sex composition of the Anvik River chum salmon escapement passing the sonar site has varied through the duration of the run, with a trend toward an increasing proportion of younger and female salmon as the run progressed (Fair 1997). This trend was also observed in each of the 1997-1999 runs (Figures 13, 14).

The overall sex composition of the 1997-1999 chum salmon escapements, as portrayed in each year's total beach seine catch, weighted by time and passage, remained relatively constant, ranging from 53.6% in 1997 to 58.1% in 1999 (Figure 15; Appendix F). Since 1979, females have dominated the escapement in all years except 1995 and 1996. Females have dominated the sex composition of age-4 Anvik River chum salmon in all years from 1979 through 1999, except for 1995 (Figure 16). The ratio of age-4 females:males averaged 1.6 in 1979-1999. Age-5 female and male chum salmon have been more closely matched in numbers, with a 1979-1999 female:male ratio of 1.1.

The annual age at maturity of the 1972-1999 Anvik River chum salmon escapements has varied widely, ranging from 3.8 to 4.8 yr (Figure 15). There may be a long-term trend toward an increasing average age at maturity, but the data have not been analyzed for significance.

Yukon River Summer Chum Salmon

In-season Anvik River chum salmon passage estimates, in conjunction with passage estimates from the Yukon River sonar project at Pilot Station, played a major role in the management of the Yukon River summer chum salmon fisheries in 1997 through 1999. Comparison of passage data from these two projects was used to assess Anvik River and non-Anvik river summer chum salmon run sizes.

Early in the 1997 commercial fishing season, Anvik River and Yukon River sonar estimates indicated that the Anvik River and non-Anvik River summer chum salmon run was below average, but there was a surplus available for commercial harvest (Bergstrom et al. 1998). Commercial fishing for summer chum salmon was allowed throughout the Yukon River drainage, but because of poor salmon markets, the harvests were well below the low end of harvest guideline ranges in most districts. Postseason analysis indicated that the total Yukon River summer chum salmon run was below average in magnitude, with a reconstructed run size estimated at 1,525,000 fish. This number is based on Yukon River sonar passage estimates and estimated harvest and escapement downriver from the sonar project at Pilot Station (J. S. Hayes, personal communication).

Commercial fishers in 1997 harvested 78,157 summer chum salmon in the Lower Yukon Area, 26,023 fish in Subdistrict 4-A below the confluence of the Anvik and Yukon Rivers (statistical area 334-44), and 13,548 female chum salmon in the Anvik River Management Area terminal harvest fishery (Bergstrom et al. 1998). Other harvests of summer chum salmon in the Lower Yukon Area were test fish program sales of 2,590 fish and a subsistence harvest of 64,535 fish. The subsistence harvest by Anvik village residents was 6,306 summer chum salmon, making the total possible harvest of Anvik River chum salmon 191,159 fish. If all summer chum salmon harvested between the Anvik River sonar project and the Coastal District of the Yukon Area were of Anvik River origin, then the maximum total Anvik River chum salmon run size was 800,277 fish, or 52% of the total Yukon River summer chum salmon run. If none of the summer chum salmon catches except the ARMA harvest were Anvik River stocks, then the minimum Anvik River chum salmon run size was 622,666 fish, or 41% of the total Yukon River summer chum salmon run.

The 1997 Yukon River and Anvik River sonar projects' assessments of summer chum salmon runs agreed with the below average escapement estimates in Kaltag Creek, Nulato River, and Clear Creek (Table 5; Bergstrom et al. 1998). The weir project on the Gisasa River counted a low number of returning fish, and the poor escapement counted through the Andreafsky River weir project indicated that the chum salmon return was well below the aerial survey goal for that river.

Early season Anvik River and Yukon River sonar estimates in 1998 indicated a late and weak Anvik and non-Anvik River summer chum salmon run (Bergstrom et al. 1999). The only summer chum salmon-directed commercial fishing period on the Yukon River was a 3-hour opening in District 1. Postseason analysis of 1998 Yukon River sonar and harvest and escapement data indicated that the total Yukon River summer chum salmon run was very weak, with a postseason reconstructed run size of 894,000 fish (J. S. Hayes, personal communication).

The total 1998 commercial summer chum salmon harvest in the Lower Yukon Area was 28,118 fish, most taken incidentally with the chinook salmon harvest (Bergstrom et al. 1999). No commercial fishing was allowed in Subdistrict 4-A or in Anvik River Management Area. Sales of

summer chum salmon from Lower Yukon Area test fish programs totaled 3,019 fish. Subsistence harvests of summer chum salmon totaled 59,640 fish in the Lower Yukon area, and 2,139 fish by Anvik village residents, so the total possible removal of Anvik River chum salmon was 92,916 fish. If all summer chum salmon harvested from the Anvik River to the Coastal District of the Yukon area were assumed to be from Anvik River stocks, then the maximum Anvik River chum salmon run size was 562,463 fish, or 63% of the total Yukon River run. If none of the summer chum salmon catches downriver of the sonar project were from Anvik River stocks, then the minimum Anvik River chum salmon run size was 469,547 fish, or 53% of the total Yukon River run.

Counting tower and weir projects in the Andreafsky River, Kaltag Creek, Nulato River, Gisasa River and Clear Creek agreed with the Yukon River and Anvik River sonar projects' assessments of very weak summer chum salmon runs in 1998 (Table 5, Bergstrom et al. 1999). None of the 1998 escapements to the Andreafsky River, Nulato River or Clear Creek met minimum goals.

In 1999, the Yukon River and Anvik River sonar projects provided early indications that the Yukon River summer chum salmon runs were late and weak (JTC 1999). There were no commercial openings in the Yukon Area directed toward summer chum salmon. Using the Yukon River sonar estimate of summer chum salmon passage and adding estimated harvest and escapement downriver of the Yukon River sonar site, the reconstructed Yukon River total summer chum salmon run size was 1,033,000 fish (J. S. Hayes, personal communication).

During the Lower Yukon chinook salmon-directed commercial fishery, 27,883 summer chum salmon were incidentally harvested (Bergstrom et al. in preparation). No commercial fishing was allowed in Subdistrict 4-A or the Anvik River management area. Sales of summer chum salmon from Lower Yukon Area test fish programs totaled 836 fish. Subsistence harvests of summer chum salmon totaled 50,054 fish caught in the Lower Yukon Area, and 848 fish taken by Anvik village residents, so the total possible harvest of Anvik River summer chum salmon was 79,621 fish. If all summer chum salmon harvested downstream of the Anvik River sonar project were assumed to be from Anvik River stocks, then the maximum Anvik River chum salmon run size was 520,926 fish, or 50% of the total Yukon River run. If none of the downriver summer chum salmon catches were Anvik River fish, then the minimum Anvik River chum salmon run size was 441,305 fish, or 43% of the Yukon River run.

The Yukon River mainstem sonar project produced a passage estimate of 939,348 summer chum salmon, which was higher than the 1998 passage estimate of 745,919 fish (Bromaghin 2000). Several summer chum salmon escapement projects in the Yukon River drainage indicated, as did the Anvik River sonar project, that 1999 escapements were lower than in 1998 (Table 5). The Andreafsky River and Gisasa River weir projects reported summer chum salmon escapements 52% and 46% lower than in 1998. The Nulato River and Kaltag Creek tower projects estimated 1999 summer chum salmon escapements to be 39% and 35%, respectively, lower than in 1998. The 1999 estimated summer chum salmon escapement to Clear Creek was 88% lower than the average of 1995-1997 escapements.

LITERATURE CITED

ADF&G (Alaska Department of Fish and Game). 1990. Arctic-Yukon Kuskokwim Region commercial and subsistence fishing regulations, salmon and miscellaneous finfish, 1990-1991 edition. Division of Commercial Fisheries, Juneau.

ADF&G (Alaska Department of Fish and Game). 1994. Salmon fisheries in the Yukon Area, Alaska, 1994. Division of Commercial Fisheries Management and Development, Regional Information Report 3A94-31, Anchorage.

Bendix Corporation. 1981. Installation and operation manual, side-scan sonar counter. Electro-dynamics Division, Division Report FISH-81-010. Report to the Alaska Department of Fish and Game, Anchorage, Alaska.

Bergstrom, D. J., and 7 co-authors. 1992. Annual management report Yukon Area, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A92-17, Anchorage.

Bergstrom, D. J., and 7 co-authors. 1998. Annual management report Yukon Area, 1997. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A98-32, Anchorage.

Bergstrom, D. J., and 10 co-authors. 1999. Annual management report Yukon Area, 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A98-32, Anchorage.

Bergstrom, D. J., and 10 co-authors. In preparation. Annual management report Yukon and Northern Areas, 1999. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report, Anchorage

Bromaghin, J.F. 1993. "Sample size determination for interval estimation of multinomial probabilities." *The American Statistician*, 47, 203-206.

Bromaghin, J.F. 2000. Yukon River sonar preliminary salmon passage estimates for 2000 and final passage estimates for 1999, 1998, 1997, and 1995. Alaska Department of Fish and Game (unpublished Division of Commercial Fisheries Region III memorandum), Anchorage.

Buklis, L. S. 1981. Yukon River salmon studies. Anadromous Fish Conservation Act completion report for period July 1, 1977 to June 30, 1981. Alaska Department of Fish and Game, Juneau.

Buklis, L. S. 1982. Anvik, Andreafsky and Tanana River salmon escapement studies, 1981. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report 15, Anchorage.

Buklis, L. S. 1983. Anvik and Andreafsky River salmon studies, 1982. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report 20, Anchorage.

Buklis, L. S. 1984a. Anvik and Andreafsky River salmon studies, 1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report 23, Anchorage.

Buklis, L. S. 1984b. Anvik and Andreafsky River salmon studies, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report 24, Anchorage.

Buklis, L. S. 1985. Anvik and Andreafsky River salmon studies, 1985. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report 26, Anchorage.

Buklis, L. S. 1986. Anvik and Andreafsky River salmon studies, 1986. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report 30, Anchorage.

Buklis, L. S. 1987. Anvik and Andreafsky River salmon studies, 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report 34, Anchorage.

Clutter, R. I., and L.W. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin of the International Pacific Salmon Fisheries Commission 9, Vancouver, British Columbia.

Crane, P.A., L.W. Seeb, R.B. Gates. 1994. Yukon River chum salmon: progress report for genetic stock identification studies July 1, 1992-June 30, 1994. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 5J94-17, Anchorage.

Fair, L.F. 1997. Anvik River salmon escapement study, 1996. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 3A97-19, Anchorage.

JTC. 1996. Yukon River Salmon Season Review for 1996 and Technical Committee Report. The United States/Canada Yukon River Joint Technical Committee, Whitehorse, Yukon Territory.

JTC. 1999. Yukon River Salmon Season Review for 1999 and Technical Committee Report. The United States/Canada Yukon River Joint Technical Committee, Whitehorse, Yukon Territory.

Lebida, R.C. 1973. Yukon River anadromous fish investigations. Alaska Department of Fish and Game (unpublished Commercial Fisheries Division Region III report), Juneau.

Mauney, J.L. 1977. Yukon River king and chum salmon escapement studies. Anadromous Fish Conservation Act Technical Report for Period July 1, 1975 to June 30, 1976. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Mauney, J.L. 1979. Yukon River salmon studies. Anadromous Fish Conservation Act Technical Report for Period July 1, 1977 to June 30, 1978. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Mauney, J.L. 1980. Yukon River salmon studies. Anadromous Fish Conservation Act Technical Report for Period July 1, 1978 to June 30, 1979. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Mauney, J.L. and L. S. Buklis 1980. Yukon River salmon studies. Anadromous Fish Conservation Act Technical Report for Period July 1, 1979 to June 30, 1980. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Mauney, J.L. and M.F. Geiger. 1977. Yukon River anadromous fish investigations. Anadromous Fish Conservation Act Completion Report for Period July 1, 1974 to June 30, 1977. Alaska Department of Fish and Game, Commercial Fisheries Division, Juneau.

Sandone, G.J. 1989. Anvik and Andreafsky River salmon studies, 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A89-03, Anchorage.

Sandone, G.J. 1990a. Anvik River salmon studies, 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A90-26, Anchorage.

Sandone, G.J. 1990b. Anvik River salmon studies, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A90-35, Anchorage.

Sandone, G.J. 1993. Anvik River salmon escapement study, 1991. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fisheries Report 93-08, Juneau.

Sandone, G.J. 1994a. Anvik River salmon escapement study, 1992. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Technical Fisheries Report 94-02, Juneau.

Sandone, G.J. 1994b. Anvik River salmon escapement study, 1993. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 3A9-28, Anchorage.

Sandone, G.J. 1995. Anvik River salmon escapement study, 1994. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 3A95-08, Anchorage.

Sandone, G.J. 1996. Anvik River salmon escapement study, 1995. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 3A96-12, Anchorage.

Trasky, L.L. 1974. Yukon River anadromous fish investigations. Anadromous Fish Conservation Act Technical Report for Period July 1, 1973 to June 30, 1974. Alaska Department of Fish and Game, Commercial Fisheries Division, Juneau.

Trasky, L.L. 1976. Yukon River king and chum salmon escapement studies. Anadromous Fish Conservation Act Technical Report for Period July 1, 1974 to June 30, 1975. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Wilcock, J. A. 1988. Feasibility of using scale pattern analysis to identify the origin of chum salmon in Yukon River fisheries, 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A88-03, Anchorage.

Wilmot, R. L., and 3 co-authors. 1992. Genetic stock identification of Yukon River chum and chinook salmon 1987 to 1990. U.S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center, Fisheries Management Services, Progress Report. Anchorage.

TABLES

Table 1. Annual Anvik River sonar passage estimates and associated passage timing statistics of the chum salmon run, 1979-1999.

Year	Sonar Passage Estimate	Day of First Salmon Counts	First Quartile Day	Median Day	Third Quartile Day	Days Between Quartiles		
						First & Median	Median & Third	First & Third
1979	277,712	23-Jun	2-Jul	8-Jul	12-Jul	6	4	10
1980	482,181	27-Jun	6-Jul	11-Jul	16-Jul	5	5	10
1981	1,479,582	20-Jun	27-Jun	2-Jul	7-Jul	5	5	10
1982	444,581	25-Jun	7-Jul	11-Jul	14-Jul	4	3	7
1983	362,912	21-Jun	30-Jun	7-Jul	12-Jul	7	5	12
1984	891,028	22-Jun	5-Jul	9-Jul	13-Jul	4	4	8
1985 [a]	1,080,243	5-Jul	10-Jul	13-Jul	16-Jul	3	3	6
1986 [b]	1,085,750	21-Jun	29-Jun	2-Jul	6-Jul	3	4	7
1987	455,876	21-Jun	5-Jul	12-Jul	16-Jul	7	4	11
1988	1,125,449	21-Jun	30-Jun	3-Jul	9-Jul	3	6	9
1989	636,906	20-Jun	1-Jul	7-Jul	13-Jul	6	6	12
1990	403,627	22-Jun	2-Jul	7-Jul	15-Jul	5	8	13
1991	847,772	21-Jun	1-Jul	10-Jul	16-Jul	9	6	15
1992	775,626	29-Jun	5-Jul	8-Jul	12-Jul	3	4	7
1993	517,409	19-Jun	5-Jul	12-Jul	18-Jul	7	6	13
1994	1,124,689	19-Jun	1-Jul	7-Jul	11-Jul	6	4	10
1995	1,339,418	19-Jun	1-Jul	6-Jul	11-Jul	5	5	10
1996	933,240	18-Jun	25-Jun	1-Jul	6-Jul	6	5	11
1997	609,118	19-Jun	28-Jun	3-Jul	10-Jul	5	7	12
1998	469,547	22-Jun	5-Jul	9-Jul	14-Jul	4	5	9
1999	441,305	27-Jun	6-Jul	10-Jul	16-Jul	4	6	9
Mean [c]	751,618 [d]	22-Jun	2-Jul	7-Jul	12-Jul	5.2	5.1	10.2
SE [c]	350,110 [d]	4.2	3.7	3.5	3.2	1.6	1.3	2.3

[a] High water delayed sonar operation. Chum salmon were not passing the site in significant numbers before 5 July.

[b] In 1986, sonar counting operations were terminated early.

[c] Excludes 1986 passage data.

[d] Includes 1986 passage data.

Table 2. Anvik River raw sonar estimates, calibration adjustment factors, and chum salmon passage estimates by bank and day, 19 June to 24 July, 1997.

	Right Bank				Left Bank				Entire River		
Date	Raw Daily Estimate	Adjust Factor	Corrected Daily Estimate	Percent of Daily Total	Raw Daily Estimate	Adjust Factor	Corrected Daily Estimate	Percent of Daily Total	Raw Daily Estimate	Corrected Daily Estimate	Corrected Season Estimate
19-Jun a	617	0.93	574	0.96	24	1.00	24	0.04	641	598	598
20-Jun	3,994	1.14	4,554	0.99	44	1.00	44	0.01	4,038	4,598	5,196
21-Jun	7,696	1.03	7,905	0.97	221	1.00	221	0.03	7,917	8,126	13,322
22-Jun	4,450	1.10	4,880	0.98	87	1.00	87	0.02	4,537	4,967	18,289
23-Jun	11,881	0.99	11,873	0.56	9,349	1.01	9,461	0.44	21,230	21,334	39,623
24-Jun	10,284	0.94	9,669	0.33	20,932	0.96	19,984	0.67	31,216	29,653	69,276
25-Jun	5,632	0.92	5,152	0.22	19,758	0.94	18,494	0.78	25,390	23,646	92,922
26-Jun	4,452	0.96	4,266	0.57	3,527	0.93	3,271	0.43	7,979	7,537	100,459
27-Jun	10,440	0.90	9,437	0.47	10,332	1.01	10,433	0.53	20,772	19,870	120,329
28-Jun	10,445	1.02	10,597	0.36	19,538	0.98	19,079	0.64	29,983	29,676	150,005
29-Jun	6,884	1.04	7,142	0.18	31,633	0.99	31,472	0.82	38,517	38,613	188,618
30-Jun	7,475	0.99	7,416	0.24	23,771	0.97	23,018	0.76	31,246	30,434	219,052
1-Jul	7,159	1.03	7,408	0.23	25,114	1.01	25,284	0.77	32,273	32,692	251,744
2-Jul	9,595	1.02	9,794	0.33	18,899	1.05	19,892	0.67	28,494	29,685	281,429
3-Jul	10,003	0.99	9,877	0.34	18,440	1.04	19,204	0.66	28,443	29,081	310,510
4-Jul	9,386	1.04	9,787	0.35	18,198	0.99	18,054	0.65	27,584	27,841	338,351
5-Jul	10,279	0.94	9,607	0.36	17,376	0.96	16,750	0.64	27,655	26,357	364,708
6-Jul	9,547	0.96	9,135	0.45	10,948	1.00	10,963	0.55	20,495	20,098	384,806
7-Jul	8,325	0.99	8,242	0.33	14,364	1.15	16,522	0.67	22,689	24,763	409,569
8-Jul	11,761	0.92	10,820	0.46	12,525	1.01	12,636	0.54	24,286	23,455	433,024
9-Jul	8,092	1.01	8,179	0.52	8,317	0.92	7,612	0.48	16,409	15,792	448,816
10-Jul	6,563	0.90	5,924	0.44	8,311	0.91	7,600	0.56	14,874	13,524	462,340
11-Jul	5,029	0.91	4,599	0.40	7,411	0.95	7,041	0.60	12,440	11,640	473,980
12-Jul	3,977	0.94	3,727	0.48	4,014	1.00	4,030	0.52	7,991	7,757	481,737
13-Jul	3,123	0.92	2,867	0.59	2,102	0.97	2,031	0.41	5,225	4,898	486,635
14-Jul	5,222	0.92	4,781	0.57	3,953	0.92	3,617	0.43	9,175	8,398	495,033
15-Jul	5,137	0.99	5,106	0.41	7,369	1.02	7,484	0.59	12,506	12,590	507,623
16-Jul	6,252	1.04	6,513	0.40	9,609	1.02	9,757	0.60	15,861	16,270	523,893
17-Jul	5,563	0.97	5,397	0.42	6,722	1.10	7,408	0.58	12,285	12,805	536,698
18-Jul	5,160	0.96	4,945	0.37	7,908	1.05	8,337	0.63	13,068	13,282	549,980
19-Jul	5,919	1.01	6,000	0.42	8,128	1.04	8,443	0.58	14,047	14,443	564,423
20-Jul	9,163	0.76	6,957	0.54	6,269	0.94	5,874	0.46	15,432	12,832	577,255
21-Jul	8,776	0.66	5,806	0.50	6,264	0.92	5,764	0.50	15,040	11,570	588,825
22-Jul	9,285	0.54	5,005	0.47	6,418	0.88	5,619	0.53	15,703	10,625	599,450
23-Jul	2,537 b	0.57	1,445	0.30	3,081	1.08	3,321	0.70	5,618	4,767	604,217
24-Jul c, d			1,486	0.30	3,176	1.08	3,415	0.70		4,901	609,118
Total	250,103		236,872		374,132		372,246		621,059	609,118	
Percent	40.3% e		38.9%		59.7% e		61.1%		100.0%	100.0%	
Mean		0.92				0.99					

a Right bank sonar counting began at 15:00. Left bank sonar counting began at 18:00.

b Right bank sonar counting terminated at 10:35; remainder of day estimated from visual tower counts.

c Left bank sonar counting terminated at 24:00.

d Daily chum passage estimated from left bank sonar counts and right/left bank proportion of daily counts on 23 July.

e Does not include 24 July.

Table 3. Anvik River raw sonar estimates, calibration adjustment factors, chum salmon and pink salmon passage estimates by bank and day, 22 June to 24 July, 1998.

	Right Bank						Left Bank						Entire River				
	Raw		Corrected	Counts Attributed to		Percent of	Raw		Corrected	Counts Attributed to		Percent of	Raw	Corrected	Counts Attributed to		
	Daily	Adjust	Daily	Chum	Pink	Daily Chum	Daily	Adjust	Daily	Chum	Pink	Daily Chum	Daily	Daily	Chum Salmon		Pink
Date	Estimate	Factor	Estimate	Salmon	Salmon	Salmon Total	Estimate	Factor	Estimate	Salmon	Salmon	Salmon Total	Estimate	Estimate	Daily	Cumulative	Salmon
22-Jun a	213	0.64	137	137	0								213	137	137	137	0
23-Jun	1,350	0.78	1,057	1,057	0								1,350	1,057	1,057	1,194	0
24-Jun	1,925	1.07	2,059	2,059	0								1,925	2,059	2,059	3,253	0
25-Jun b	2,856	1.03	2,946	2,946	0	94.4%	175	1.00	175	175	0	5.6%	3,031	3,121	3,121	6,374	0
26-Jun	3,611	0.97	3,510	3,510	0	93.2%	321	0.80	256	256	0	6.8%	3,932	3,766	3,766	10,140	0
27-Jun	4,353	1.02	4,452	4,452	0	96.3%	239	0.71	169	169	0	3.7%	4,592	4,621	4,621	14,761	0
28-Jun	3,476	1.19	4,138	4,138	0	92.1%	387	0.92	357	357	0	7.9%	3,863	4,495	4,495	19,256	0
29-Jun	3,735	1.08	4,023	4,023	0	82.4%	861	1.00	861	861	0	17.6%	4,596	4,884	4,884	24,140	0
30-Jun	6,277	1.07	6,690	6,690	0	82.7%	1,493	0.94	1,396	1,396	0	17.3%	7,770	8,086	8,086	32,226	0
1-Jul	13,145	0.98	12,838	12,838	0	88.4%	1,896	0.89	1,687	1,687	0	11.6%	15,041	14,525	14,525	46,751	0
2-Jul	14,821	0.96	14,268	14,268	0	96.0%	538	1.12	600	600	0	4.0%	15,359	14,868	14,868	61,619	0
3-Jul	22,169	1.04	23,102	23,102	0	93.8%	1,405	1.24	1,529	1,529	0	6.2%	23,574	24,631	24,631	86,250	0
4-Jul	21,899	0.97	21,150	21,150	0	91.3%	2,564	0.79	2,028	2,028	0	8.7%	24,463	23,178	23,178	109,428	0
5-Jul	22,906	1.01	23,151	23,151	0	91.1%	2,385	0.95	2,256	2,256	0	8.9%	25,291	25,407	25,407	134,835	0
6-Jul	30,237	0.96	28,997	28,997	0	84.6%	5,719	0.92	5,263	5,263	0	15.4%	35,956	34,260	34,260	169,095	0
7-Jul	31,398	0.98	31,206	31,206	0	86.9%	5,592	0.85	4,724	4,724	0	13.1%	36,990	35,930	35,930	205,025	0
8-Jul	14,639	1.00	14,653	14,653	0	86.3%	2,382	0.98	2,323	2,323	0	13.7%	17,021	16,976	16,976	222,001	0
9-Jul c	11,121	0.98	15,302	15,302	0	85.0%			2,704	2,704 d	0	15.0%	11,121	18,006	18,006	240,007	0
10-Jul			19,262	19,262 e	0	86.1%			3,117	3,117 d	0	13.9%		22,379	22,379	262,386	0
11-Jul f	10,963	0.97	23,221	23,221	0	86.8%			3,530	3,530 d	0	13.2%	10,963	26,751	26,751	289,137	0
12-Jul	25,022 g	1.05	26,158	23,314	2,844	86.8%			3,540	3,540 d	0	13.2%	25,022 g	29,698	26,854	315,991	2,844
13-Jul	26,801 g	0.99	26,474	22,172	4,302	86.6%			3,421	3,421 d	0	13.4%	26,801 g	29,895	25,593	341,584	4,302
14-Jul	16,306 g	0.96	15,710	13,157	2,553	84.1%			2,480	2,480 d	0	15.9%	16,306 g	18,190	15,637	357,221	2,553
15-Jul h	13,582 g	1.00	13,579	6,556	7,023	72.8%	4,751 g	0.97	5,642	2,446	3,196	27.2%	18,333 g	19,221	9,002	366,223	10,219
16-Jul	21,160 g	0.96	20,346	12,767	7,579	69.2%	13,869 g	0.77	10,671	5,670	5,001	30.8%	35,029 g	31,017	18,437	384,660	12,580
17-Jul	19,255 g	0.94	18,125	11,362	6,763	76.1%	9,827 g	0.98	9,590	3,562	6,028	23.9%	29,082 g	27,715	14,924	399,584	12,791
18-Jul	12,049 g	1.07	12,872	8,327	4,545	68.0%	10,134 g	0.96	9,713	3,911	5,802	32.0%	22,183 g	22,585	12,238	411,822	10,347
19-Jul	23,317 g	0.90	20,914	12,517	8,397	76.8%	12,257 g	0.96	11,705	3,790	7,915	23.2%	35,574 g	32,619	16,307	428,129	16,312
20-Jul	22,752 g	0.91	20,714	8,196	12,518	69.3%	11,904 g	1.05	12,476	3,631	8,845	30.7%	34,656 g	33,190	11,827	439,956	21,363
21-Jul	12,689 g	0.96	12,171	6,758	5,413	63.2%	10,237 g	1.04	10,598	3,939	6,659	36.8%	22,926 g	22,769	10,697	450,653	12,072
22-Jul	15,590 g	1.01	15,773	6,263	9,510	63.7%	15,000 g	0.95	14,241	3,574	10,667	36.3%	30,590 g	30,014	9,837	460,490	20,177
23-Jul	12,983 g	1.06	13,694	5,318	8,376	86.9%	7,458 g	1.01	7,560	805	6,755	13.1%	20,441 g	21,254	6,123	466,613	15,131
24-Jul i	5,934 g	0.98	5,805	2,540	3,265	86.6%	2,145 g	1.18	2,533	394	2,139	13.4%	8,079 g	8,338	2,934	469,547	5,404
Total	448,534 g		478,497	395,409	83,088		123,539 g		137,145	74,138	63,007		572,073 g	615,642	469,547		146,095
Percent	74.2% j		77.7%	84.2%	56.9%		25.8% j		22.3%	15.8%	43.1%		100.0%	100.0%	100.0%		100.0%
Mean		0.98 j						0.96 j									

a Right bank sonar counting began at 00:00.

b Left bank sonar counting began at 11:45.

c Due to flooding, left bank sonar counting terminated at 00:00, right bank sonar counting terminated at 19:00.

d Interpolated using relationship of right:left bank chum salmon estimates on days with complete sonar-based estimates from both banks.

e Interpolated from 9-July and 11-July right bank chum salmon estimates.

f Right bank sonar counting resumed at 13:00.

g Raw estimates include pink salmon on right bank after 11-July, and on left bank after 14-July.

h Left bank sonar counting resumed at 09:00.

i Left bank sonar counting terminated at 11:30. Right bank sonar counting terminated at 12:30.

j Does not include days with interpolations.

Table 4. Anvik River raw sonar estimates, calibration adjustment factors, and chum salmon passage estimates by bank and day, 27 June to 28 July, 1999.

	Right Bank				Left Bank				Entire River		
Date	Raw Daily Estimate	Adjust Factor	Corrected Daily Estimate	Percent of Daily Total	Raw Daily Estimate	Adjust Factor	Corrected Daily Estimate	Percent of Daily Total	Raw Daily Estimate	Corrected Daily Estimate	Corrected Season Estimate
27-Jun a	83	1.00	83	0.98	2	1.00	2	0.02	85	85	85
28-Jun	238	1.00	238	0.87	36	1.00	36	0.13	274	274	359
29-Jun	1,389	1.06	1,477	0.96	69	1.00	69	0.04	1,458	1,546	1,905
30-Jun	2,681	1.12	2,997	0.93	220	1.00	220	0.07	2,901	3,217	5,122
1-Jul	10,683	0.89	9,551	0.95	550	0.92	507	0.05	11,233	10,058	15,180
2-Jul	10,195	1.03	10,498	0.93	647	1.15	746	0.07	10,842	11,244	26,424
3-Jul	13,653	1.02	13,889	0.87	1,836	1.10	2,013	0.13	15,489	15,902	42,326
4-Jul	18,801	0.96	18,055	0.87	4,297	0.62	2,663	0.13	23,098	20,718	63,044
5-Jul	19,964	0.97	19,358	0.63	12,280	0.93	11,419	0.37	32,244	30,777	93,821
6-Jul	9,912	1.02	10,067	0.36	18,813	0.96	18,008	0.64	28,725	28,075	121,896
7-Jul	15,250	1.09	16,621	0.48	20,111	0.90	18,062	0.52	35,361	34,683	156,579
8-Jul	14,782	0.92	13,625	0.48	14,023	1.33	14,481	0.52	28,805	28,106	184,685
9-Jul	14,749	0.78	11,558	0.53	10,386	0.97	10,086	0.47	25,135	21,644	206,329
10-Jul	15,332	0.98	14,988	0.50	16,217	0.92	14,793 b	0.50	31,549	29,781	236,110
11-Jul	9,428	0.92	8,654	0.38	15,028	0.96	14,362	0.62	24,456	23,016	259,126
12-Jul	8,118	0.89	7,218	0.43	11,032	0.87	9,583	0.57	19,150	16,801	275,927
13-Jul	8,505	0.97	8,228	0.54	7,155	1.00	7,118	0.46	15,660	15,346	291,273
14-Jul	9,383	0.89	8,353	0.61	5,588	0.96	5,352	0.39	14,971	13,705	304,978
15-Jul	10,003	0.92	9,222	0.71	4,126	0.92	3,787	0.29	14,129	13,009	317,987
16-Jul	14,188	0.89	12,629	0.72	4,490	1.09	4,895	0.28	18,678	17,524	335,511
17-Jul	12,752	0.94	11,953	0.80	3,306	0.93	3,058	0.20	16,058	15,011	350,522
18-Jul	11,345	0.94	10,642	0.76	3,426	0.99	3,378	0.24	14,771	14,020	364,542
19-Jul	11,695	0.92	10,798	0.72	4,144	1.04	4,291	0.28	15,839	15,089	379,631
20-Jul	10,877	0.94	10,272	0.77	3,060	1.02	3,126	0.23	13,937	13,398	393,029
21-Jul	9,728	1.09	10,565	0.81	2,365	1.07	2,529	0.19	12,093	13,094	406,123
22-Jul	7,279	0.90	6,560	0.77	1,835	1.04	1,906	0.23	9,114	8,466	414,589
23-Jul	6,621	1.02	6,740	0.77	2,004	0.98	1,971	0.23	8,625	8,711	423,300
24-Jul	4,766	1.02	4,880	0.78	1,502	0.93	1,402	0.22	6,268	6,282	429,582
25-Jul	3,165	1.05	3,331	0.73	1,271	0.99	1,256	0.27	4,436	4,587	434,169
26-Jul	1,767	1.02	1,798	0.73	623	1.08	671	0.27	2,390	2,469	436,638
27-Jul	2,469	0.95	2,348	0.86	380	1.00	380	0.14	2,849	2,728	439,366
28-Jul c	1,715	1.01	1,728	0.89	211	1.00	211	0.11	1,926	1,939	441,305
Total	291,516		278,924		171,033		162,381		462,549	441,305	
Percent	63.0%		63.2%		37.0%		36.8%		100.0%	100.0%	
Mean		0.97				0.99					

a Right bank and east bank sonar counting began at 00:00.

b Left bank counts adjusted down due to spawner in the sonar beam.

c Left bank sonar counting terminated at 18:30. Right bank sonar counts terminated at 24:00.

Table 5. Summer chum salmon escapement estimates for selected spawning areas in the Alaskan portion of the Yukon River drainage, 1973-1999.[a]

	Andreafsky River			Anvik River		Rodo River	Kaltag Creek	Nulato River			Gisasa River		Hogatza River		Tozitna River	Chena River		Salcha River	
	East Fork		West Fork					South Fork	North Fork [c]	Mainstem			Clear & Caribou Cr.	Clear Cr.					
Year	Aerial	Sonar, Tower, or Weir Counts	Aerial	Tower & Aerial [b]	Sonar	Aerial	Tower	Aerial	Aerial	Tower	Aerial	Weir	Aerial	Tower	Aerial	Aerial	Tower	Aerial	Tower
1973	10,149 [d]		51,835	249,015												79 [d]		290	
1974	3,215 [d]		33,578	411,133		16,137		29,016	29,334		22,022				1,823	4,349		3,510	
1975	223,485		235,954	900,967		25,335		51,215	87,280		56,904		22,355		3,512	1,670		7,573	
1976	105,347		118,420	511,475		38,258		9,230 [d]	30,771		21,342		20,744		725 [d]	685		6,484	
1977	112,722		63,120	358,771		16,118		11,385	58,275		2,204 [d]		10,734		761 [d]	610		677 [d]	
1978	127,050		57,321	307,270		17,845		12,821	41,659		9,280 [d]		5,102		2,262	1,609		5,405	
1979	66,471		43,391		280,537			1,506	35,598		10,962		14,221			1,025 [d]		3,060	
1980	36,823 [d]		114,759		492,676			5,702 [d]	11,244 [d]		10,388		19,786		580	338		4,140	
1981	81,555	147,312 [f]			1,486,182			14,348								3,500		8,500	
1982	7,501 [d]	181,352 [f]	7,267 [d]		444,581						334 [d]		4,984 [d]		874	1,509		3,756	
1983		110,608 [f]			362,912			1,263 [d]	19,749		2,356 [d]		28,141		1,604	1,097		716 [d]	
1984	95,200 [d]	70,125 [f]	238,565		891,028								184 [d]			1,861		9,810	
1985	66,146		52,750		1,080,243	24,576		10,494	19,344		13,232		22,566		1,030	1,005		3,178	
1986	83,931	167,614 [g]	99,373		1,189,602			16,848	47,417		12,114				1,778	1,509		8,028	
1987	6,687 [d]	45,221 [g]	35,535		455,876			4,094	7,163		2,123		5,669 [d]			333		3,657	
1988	43,056	68,937 [g]	45,432		1,125,449	13,872		15,132	26,951		9,284		6,890		2,983	432		2,889 [d]	
1989	21,460 [d]				636,906											714 [d]		1,574 [d]	
1990	11,519 [d]		20,426 [d]		403,627	1,941 [d]		3,196 [d, h]	1,419 [d]		450 [d]		2,177 [d]		36	245 [d]		450 [d]	
1991	31,886		46,657		847,772	3,977		13,150	12,491		7,003		9,947		93	115 [d]		154 [d]	
1992	11,308 [d]		37,808 [d]		775,626	4,465		5,322	12,358		9,300		2,986		794	848 [d]		3,222	
1993	10,935 [d]		9,111		517,409	7,867		5,486	7,698		1,581				970	168	5,400	212	5,809
1994		200,981 [j, k]			1,124,689		47,295			148,762 [k]	6,827	51,116 [k]	8,247 [l]			1,137	9,984 [k]	4,916 [d]	39,450
1995		172,148 [j]			1,339,418	12,849	77,193	10,875	29,949	236,890 [g]	6,458	136,886		116,735	4,985	185 [d]	3,519 [k]	934 [d]	30,784
1996		108,450 [j]			933,240	4,380	51,269	8,490 [d, h]		129,694 [g]		157,589	27,090 [d]	100,912	2,310	2,061 [d]	12,810 [k]	9,722 [d]	74,827 [k]
1997		51,139 [j]			609,118	2,775 [d]	48,018			157,975 [g]	686 [d]	31,800	1,821 [d]	76,454	428 [d]	594 [d]	9,439 [k]	3,968 [d]	35,741 [k]
1998		67,591 [j]			469,547		8,113			49,140 [g]		18,228	120 [d]	212 [k]	7 [d]	24 [d]	5,901 [k]	370 [d]	17,289 [k]
1999 [m]		32,229 [j]			441,305		5,300			30,076 [g]		9,920		11,300			9,165 [k]		23,221 [g]
E.O. [n]	>109,000		>116,000		>500,000				>53,000 [o]				>17,000 [p]					>3,500	

[a] Aerial survey counts are peak counts only; survey rating is fair or good unless otherwise noted.
[b] From 1972-1979 counting tower operated; escapement estimate listed is the tower counts plus expanded aerial survey counts below the tower (see Buklis 1982).
[c] Includes mainstem counts below the confluence of the North and South Forks, unless otherwise noted.
[d] Incomplete survey and/or poor survey timing or conditions resulted in minimal or inaccurate count.
[f] Sonar count.
[g] Tower count.
[h] Mainstem counts below the confluence of the North and South Forks Nulato River included in the South Fork counts.
[j] Weir Count.
[k] Incomplete count due to late installation and/or early removal of project or high water events.
[l] Consists of Clear Creek only.
[m] Data are preliminary.
[n] Interim escapement objective.
[o] Interim escapement objective for North Fork Nulato River only.
[p] Consists of Clear and Caribou Creeks interim escapement objectives of 9,000 and 8,000, respectively.

FIGURES

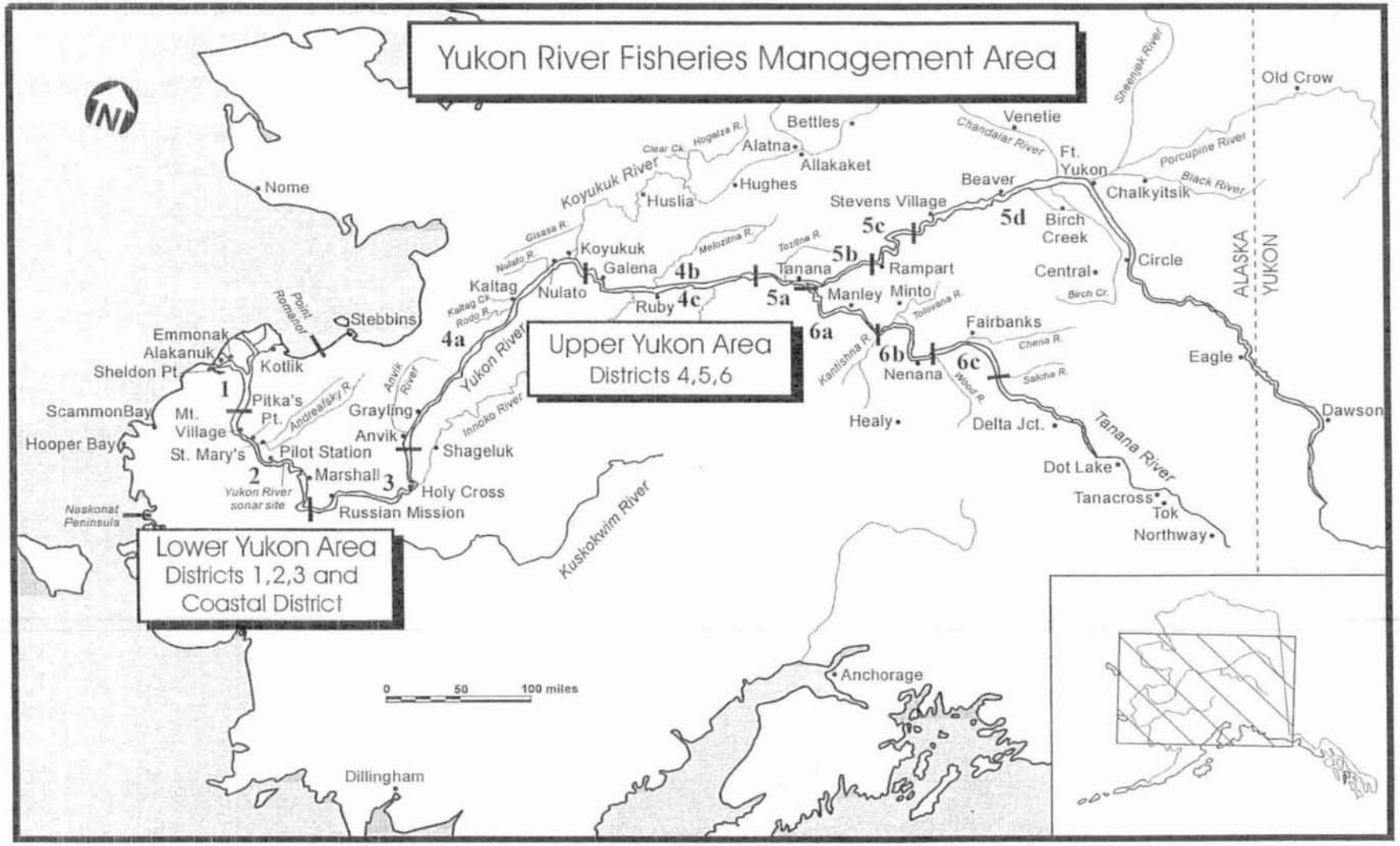


Figure 1. Alaska portion of the Yukon River drainage showing communities and fishing districts.

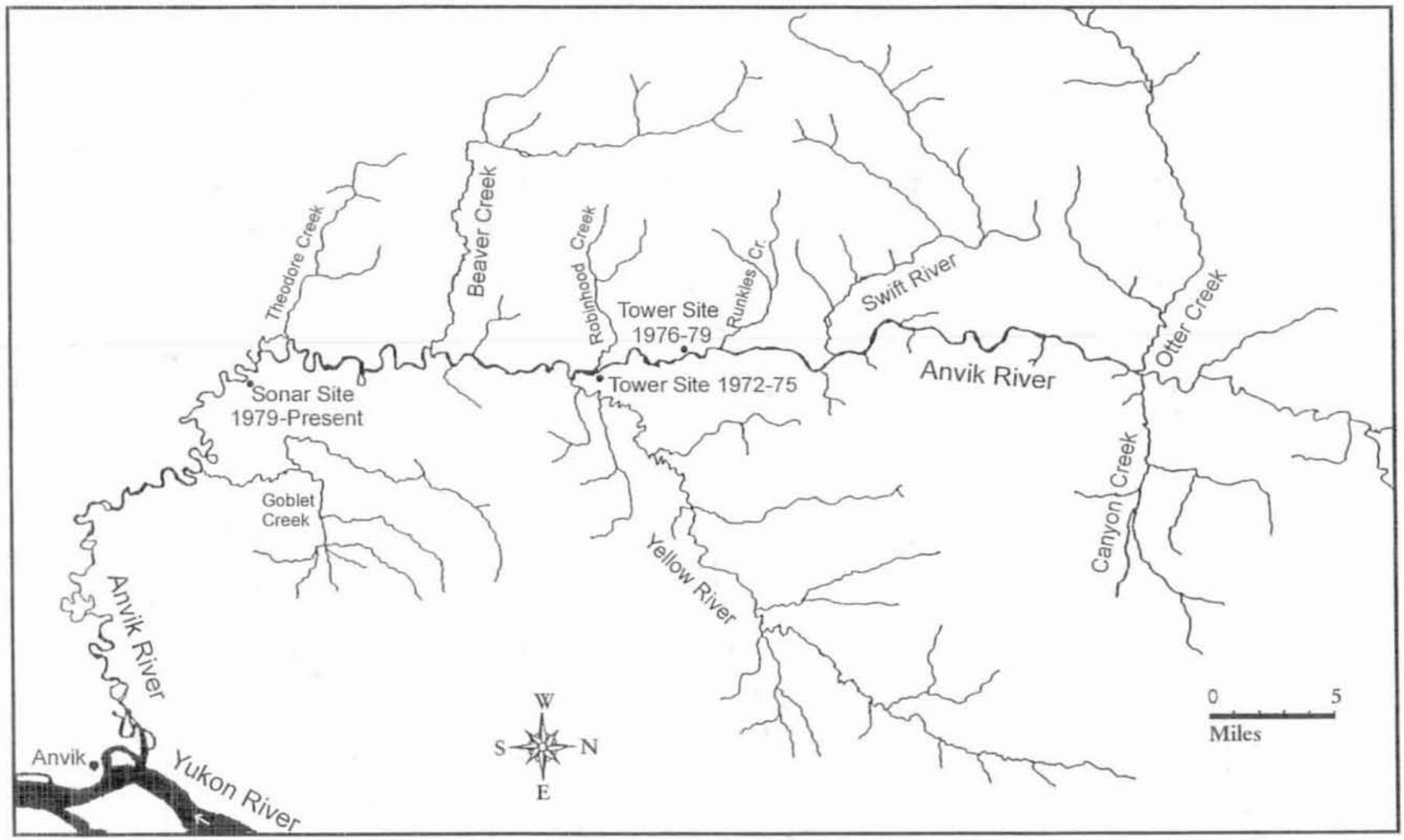


Figure 2. Map of the Anvik River drainage, with chum salmon escapement project locations.

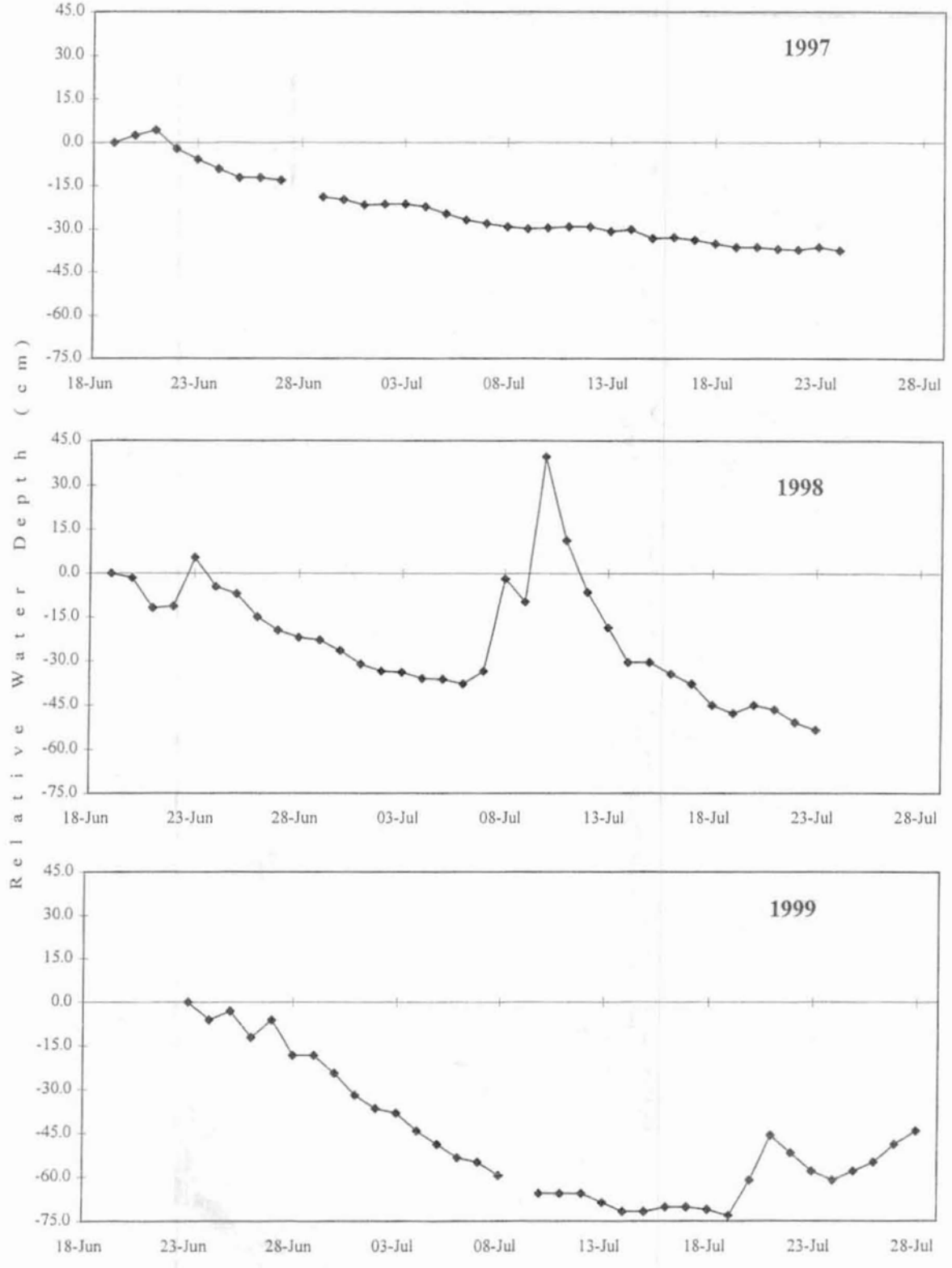


Figure 3. Daily water level at the Anvik River sonar site relative to the initial observation of each season, 1997-1999.

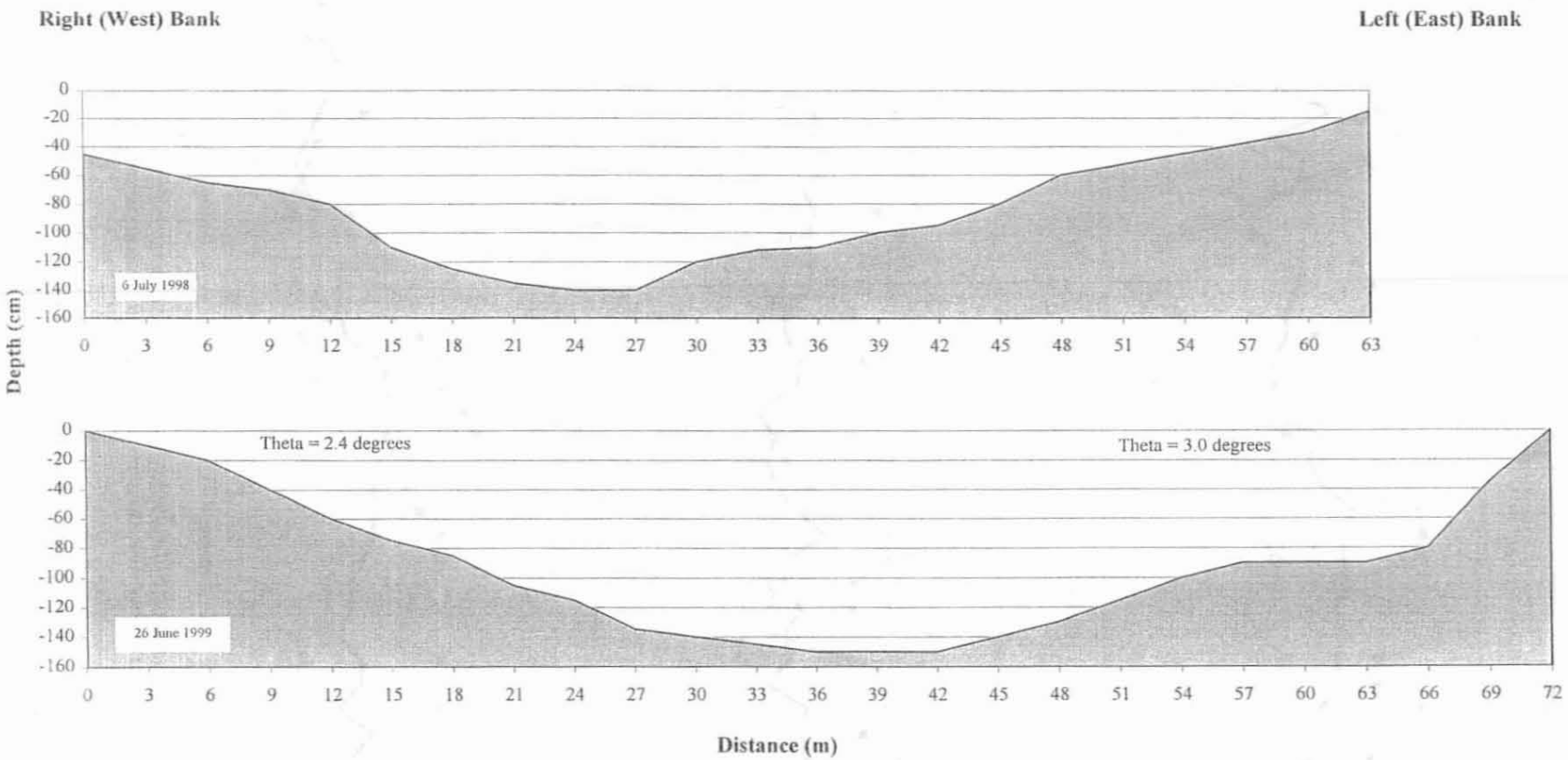


Figure 4. Depth profiles of the Anvik River sonar site on 6 July 1998 (above) and 26 June 1999 (below).

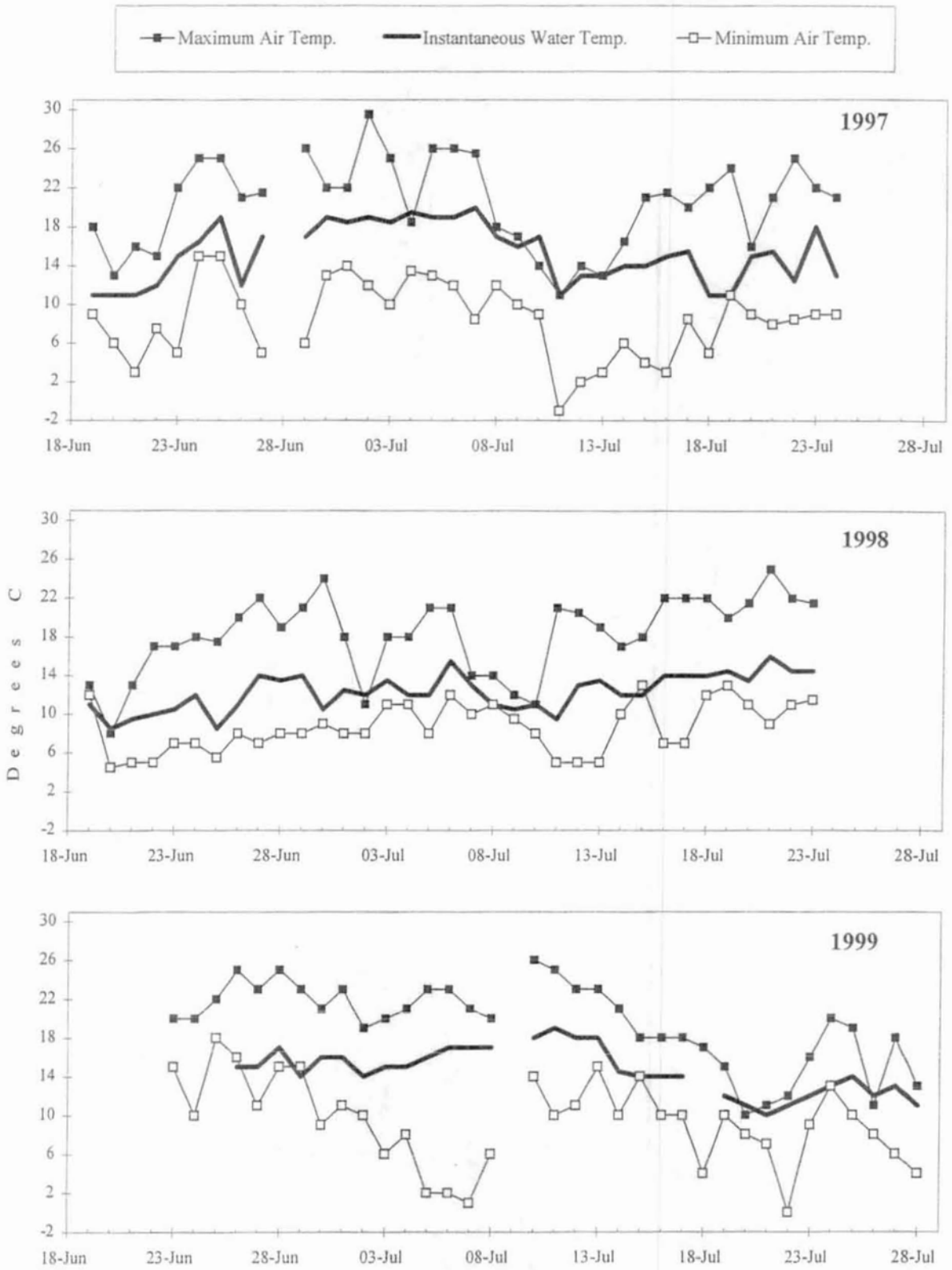


Figure 5. Daily minimum and maximum air temperatures, and daily water temperature measured at 18:00 at the Anvik River sonar site, 1997-1999.

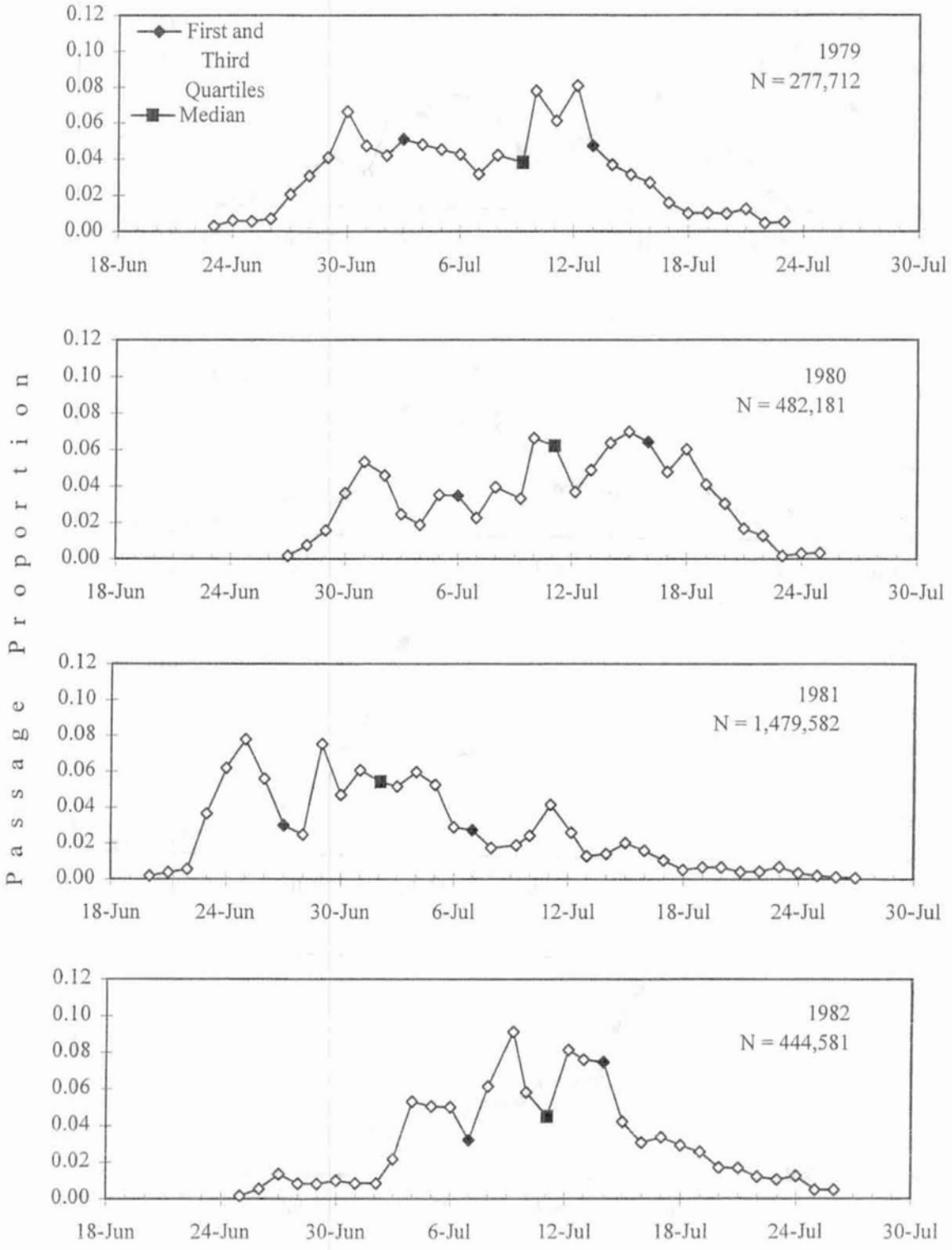


Figure 6. Daily proportion of corrected Anvik River chum salmon estimates, showing quartile and median passage days, 1979-1999. N = sum of corrected estimates.

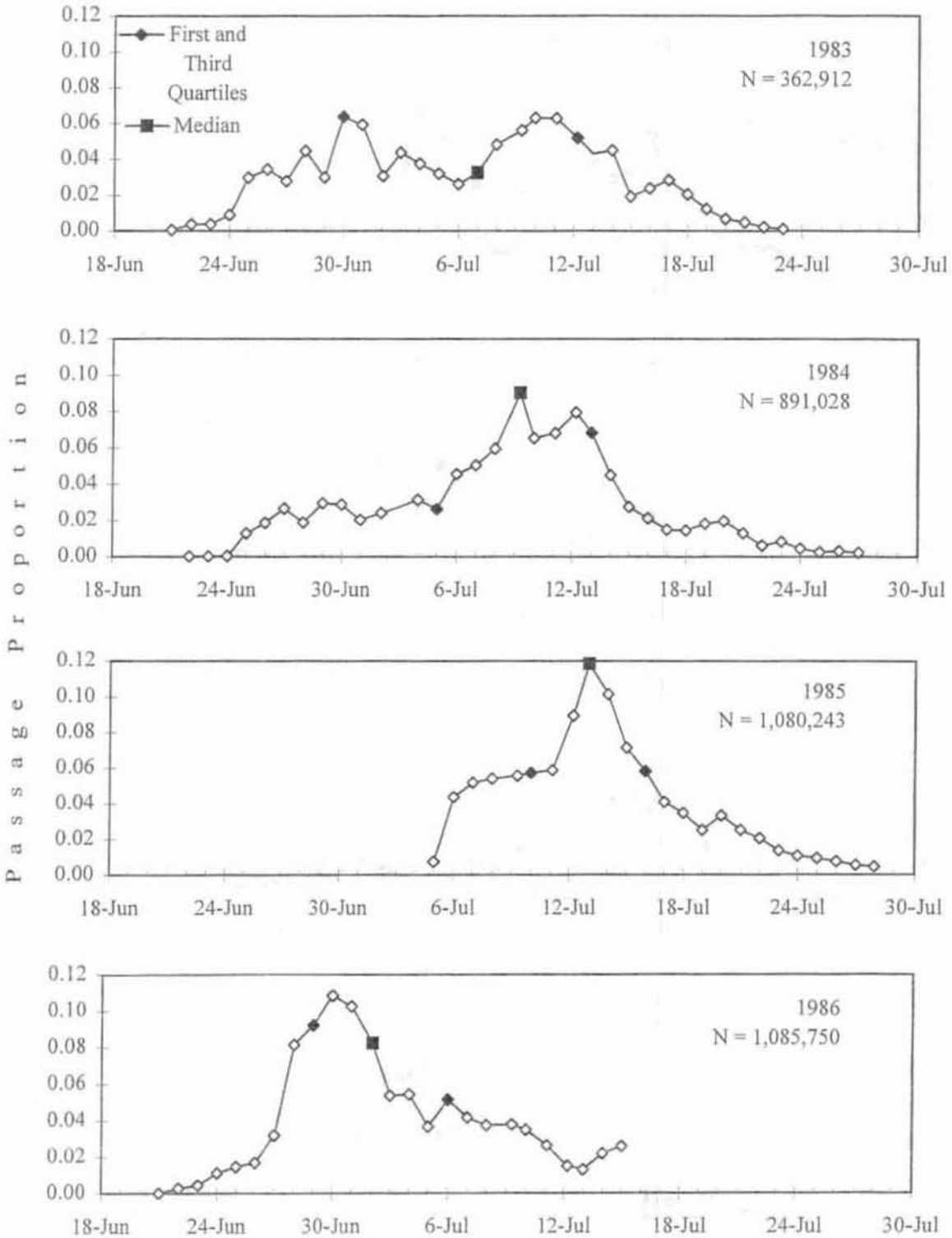


Figure 6. (page 2 of 6) Daily proportion of corrected Anvik River chum salmon estimates, showing quartile and median passage days, 1979-1999. N = sum of corrected estimates.

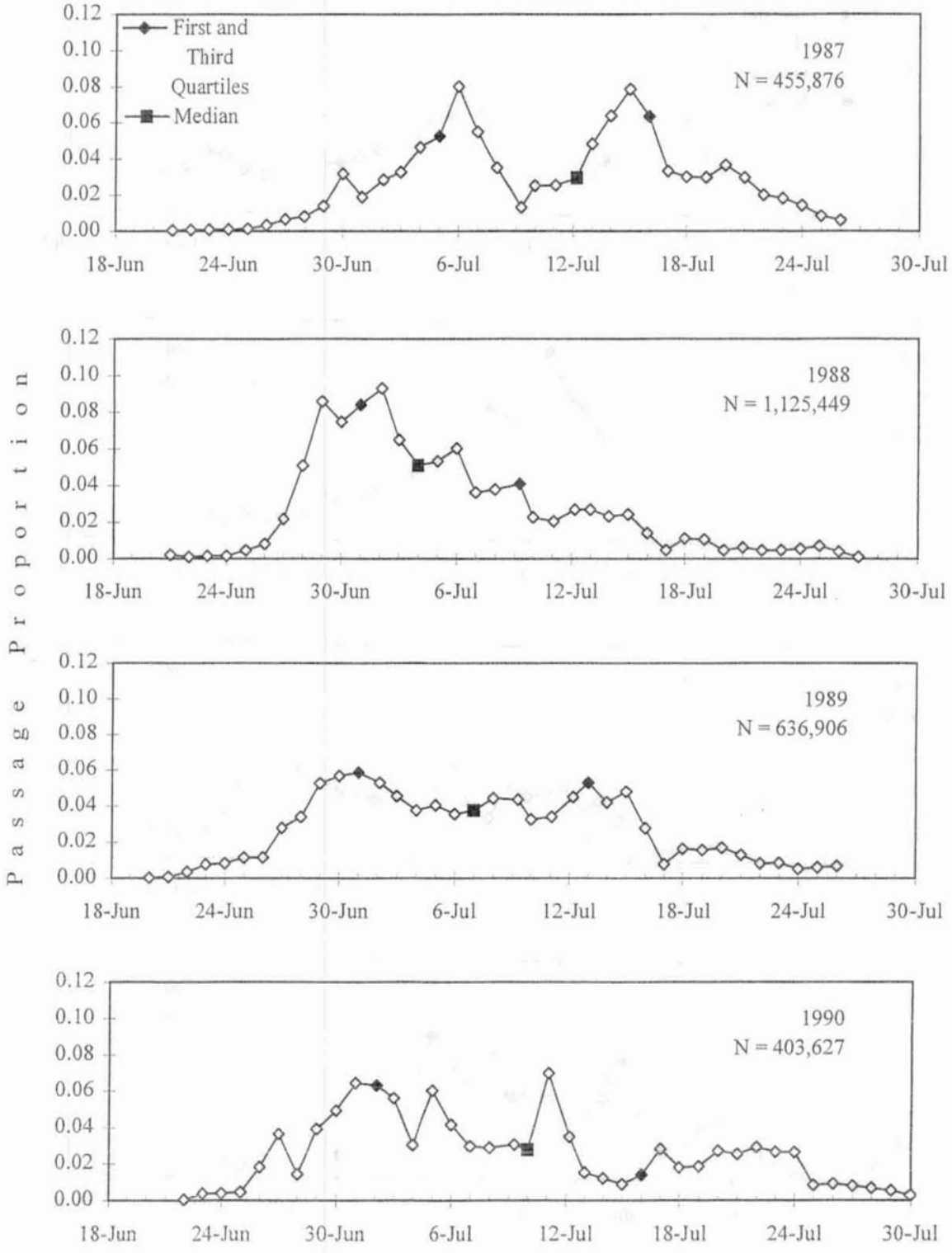


Figure 6. (page 3 of 6) Daily proportion of corrected Anvik River chum salmon estimates, showing quartile and median passage days, 1979-1999. N = sum of corrected estimates.

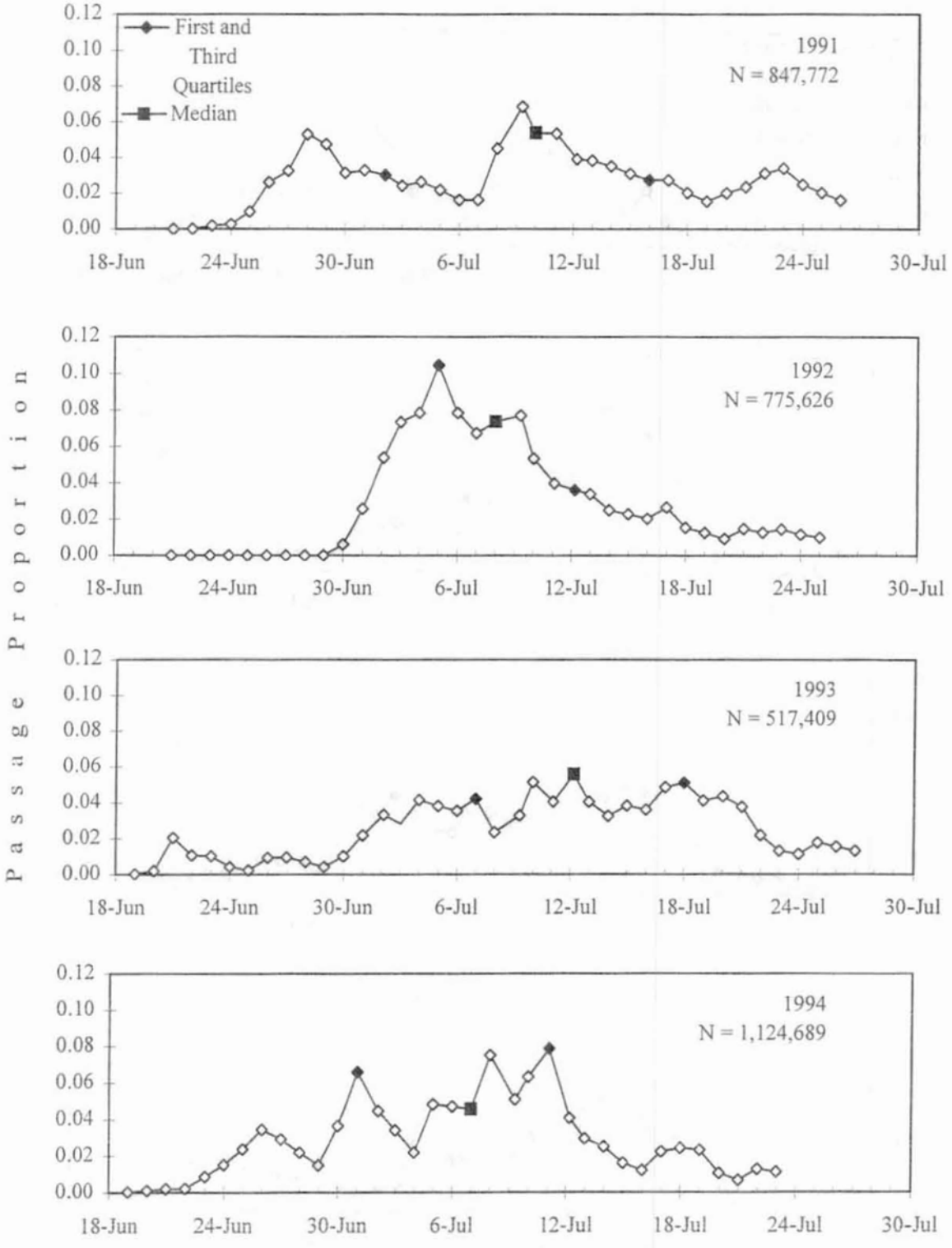


Figure 6. (page 4 of 6) Daily proportion of corrected Anvik River chum salmon estimates, showing quartile and median passage days, 1979-1999. N = sum of corrected estimates.

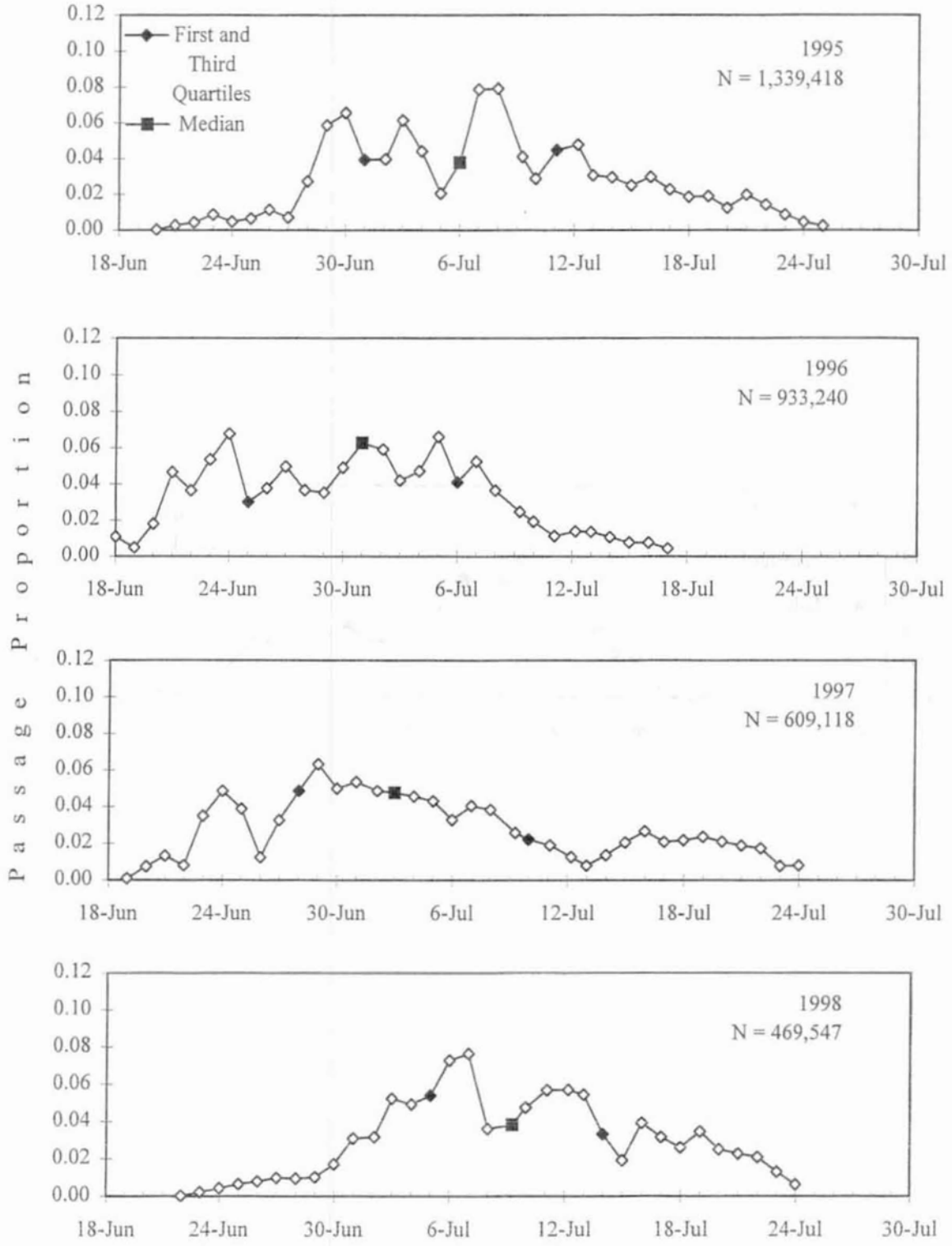


Figure 6. (page 5 of 6) Daily proportion of corrected Anvik River chum salmon estimates, showing quartile and median passage days, 1979-1999. N = sum of corrected estimates.

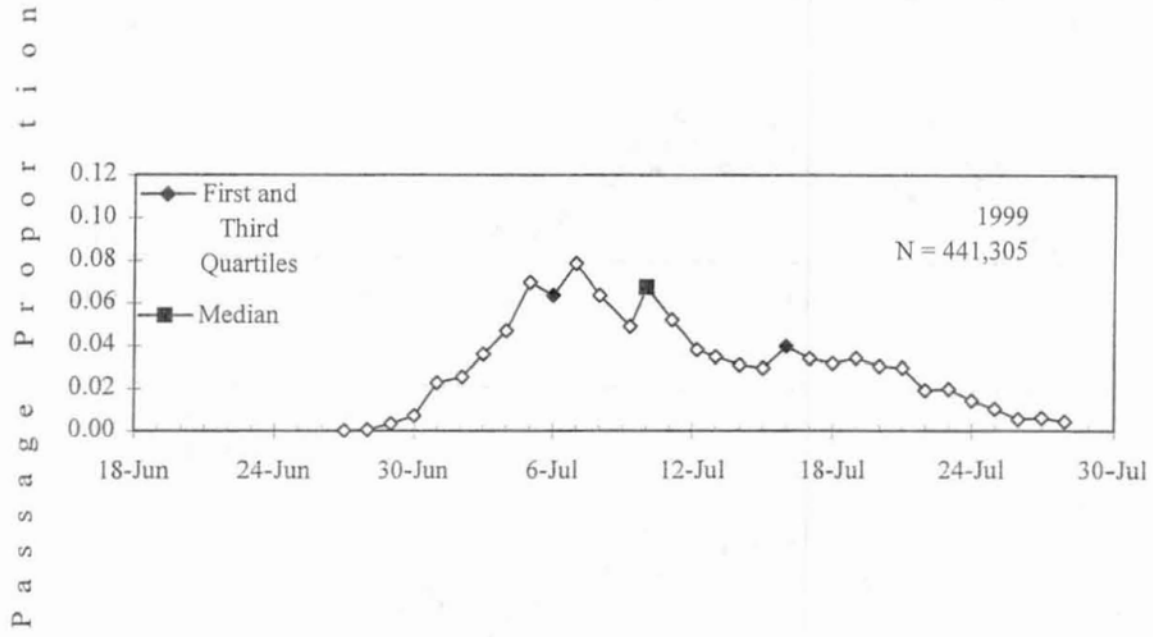


Figure 6. (page 6 of 6) Daily proportion of corrected Anvik River chum salmon estimates, showing quartile and median passage days, 1979-1999. N = sum of corrected estimates.

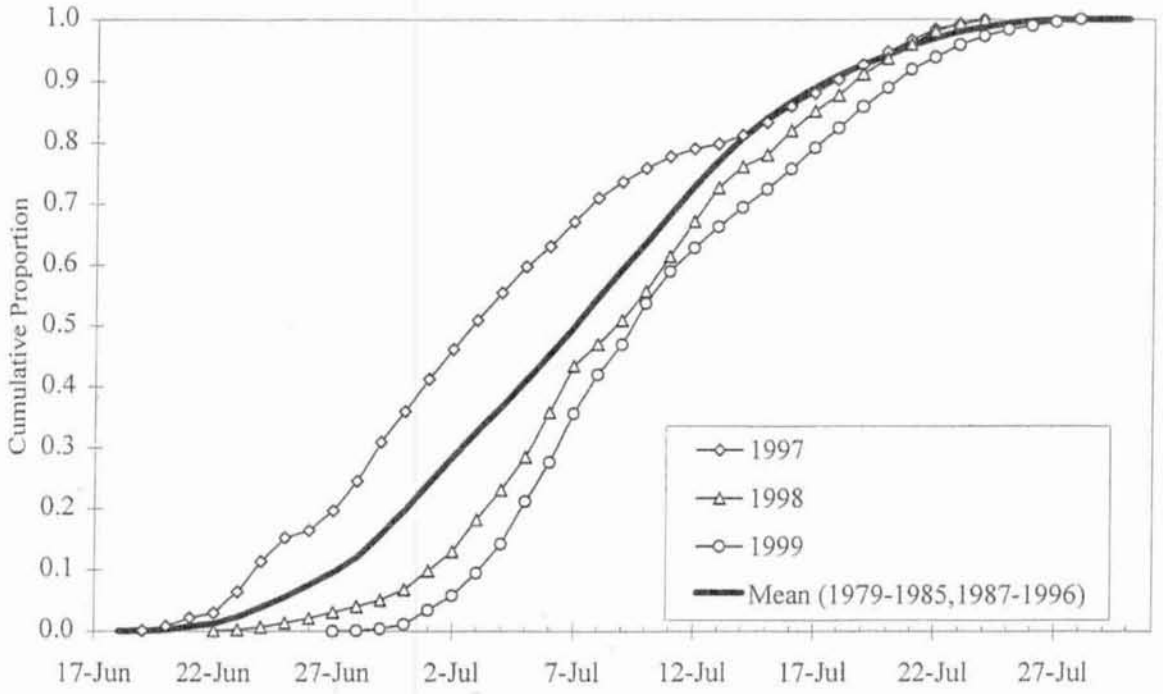


Figure 7. Annual Anvik River chum salmon run timing curves compared to the mean (1979-1985 and 1987-1996), 1997-1999.The 1986 timing statistics are excluded from the mean because the sonar project was terminated early for lack of funding.

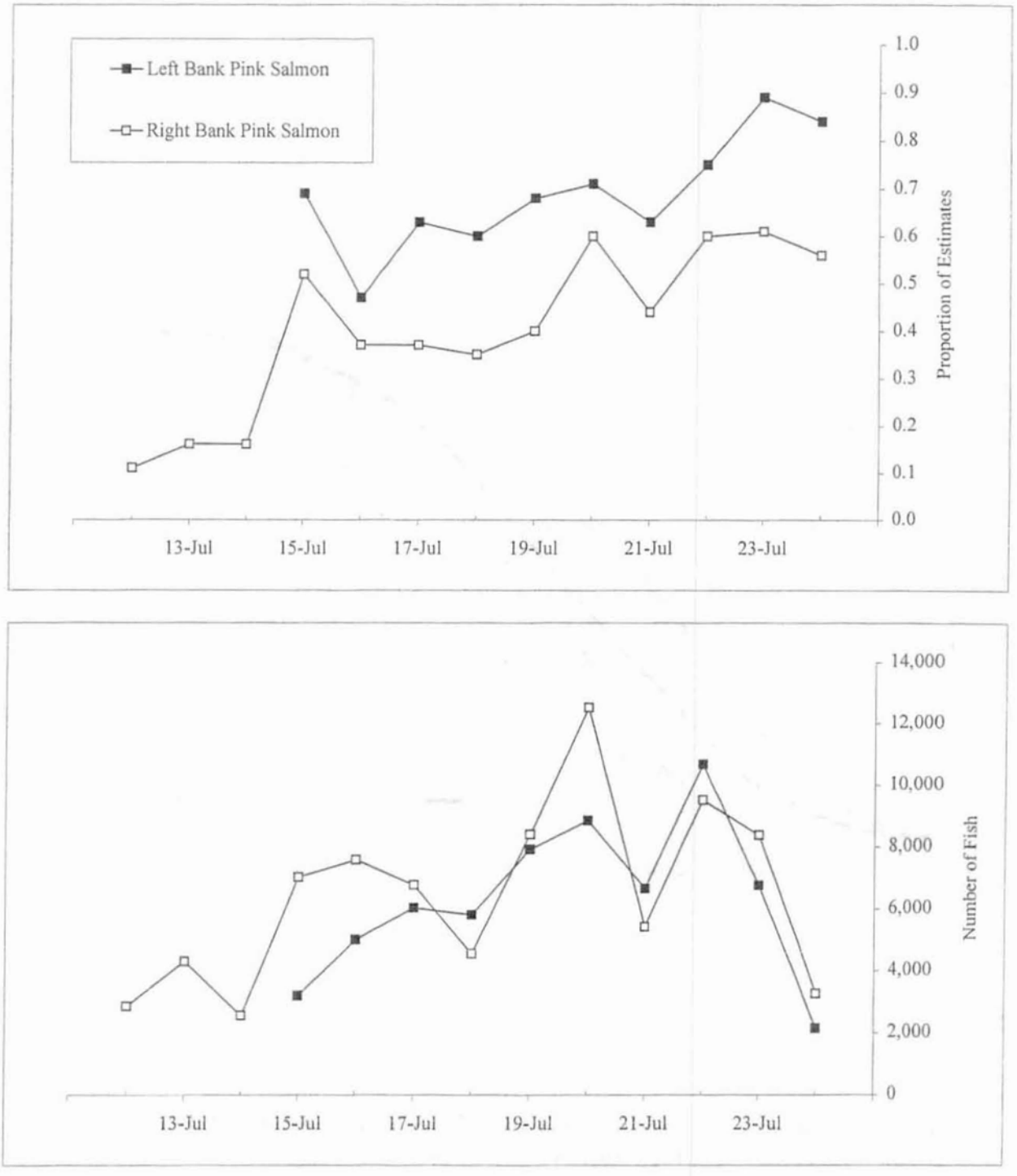


Figure 8. Daily Anvik River pink salmon estimates by bank as a proportion of all salmon estimates (above), and as numbers of fish passing the sonar site (below), from 8 to 24 July, 1998.

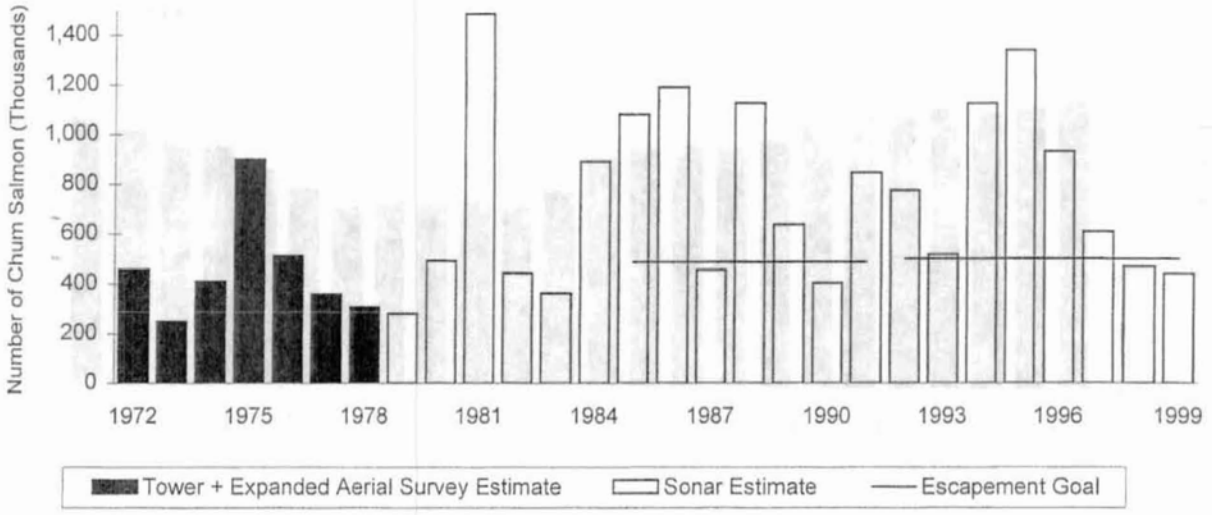


Figure 9. Anvik River chum salmon escapement estimates by combined tower and expanded aerial survey (1972-1978) and sonar (1979-1999). From 1985 to 1991 the escapement goal was 487,000 fish. Since 1992, the goal has been 500,000 fish.

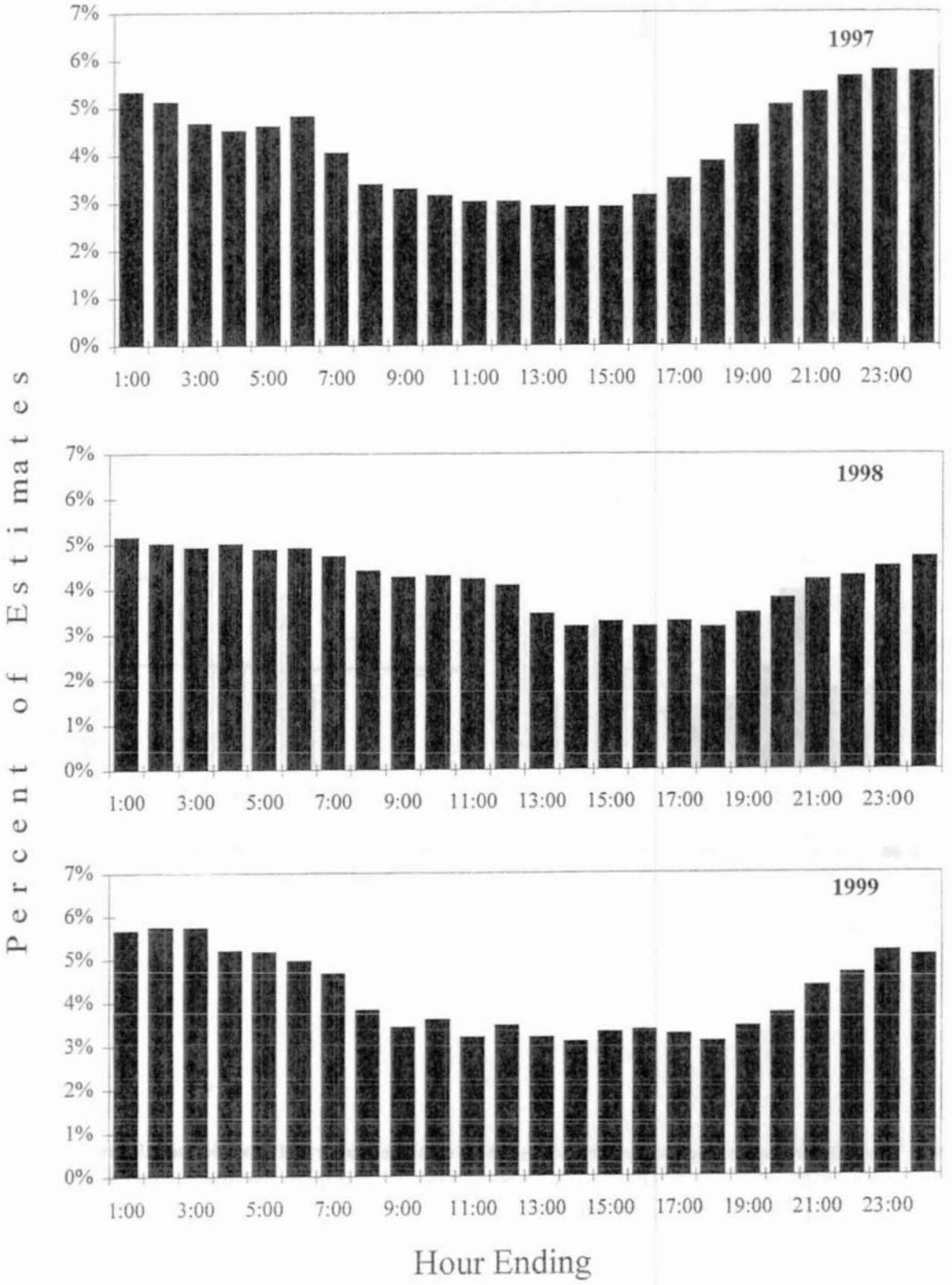


Figure 10. Percent of Anvik River corrected sonar estimates by hour of the day, 1997-1999.

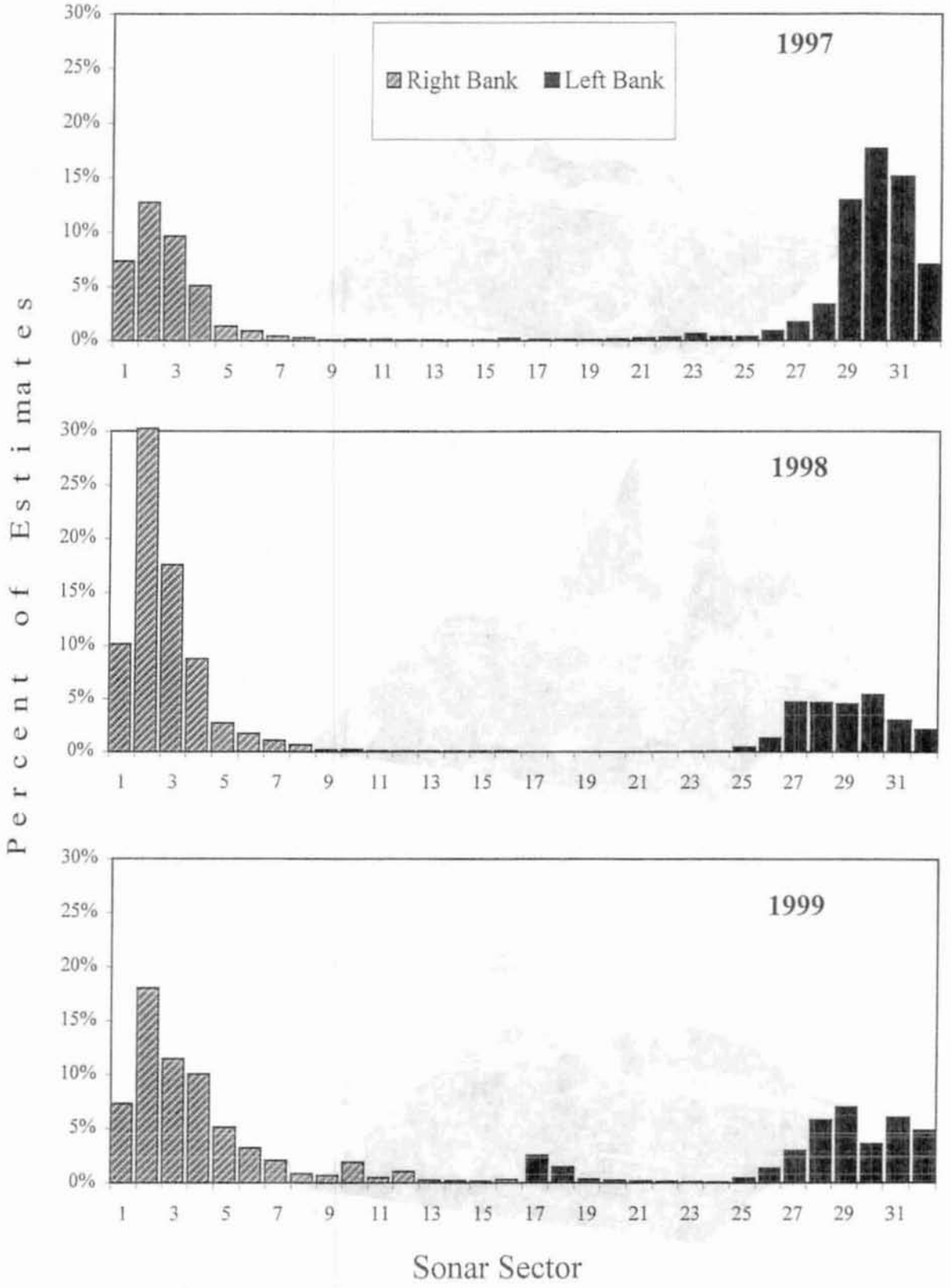
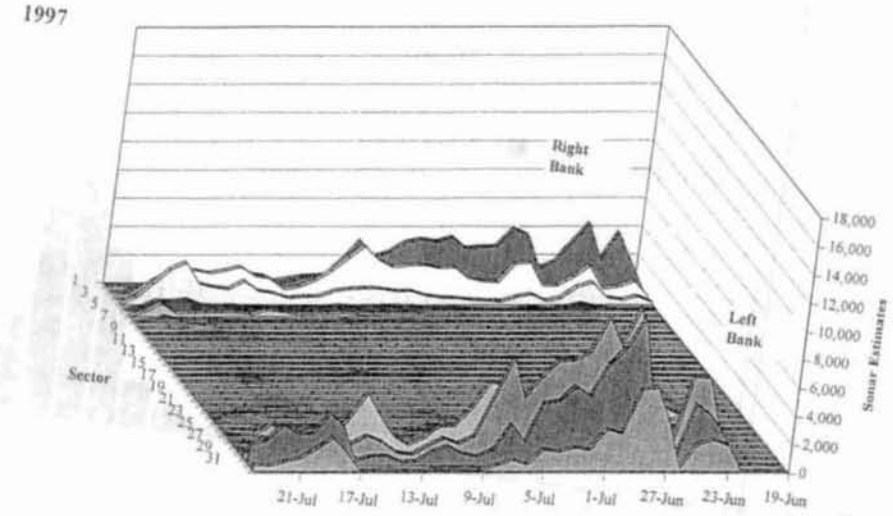
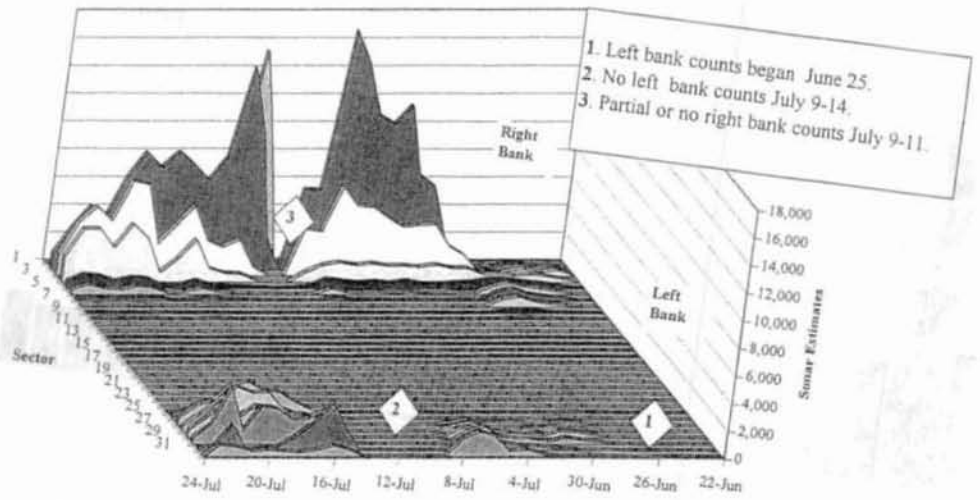


Figure 11. Percent of Anvik River corrected sonar estimates by sector, 1997-1999. Note that only days with full 24-hr counts were used.

1997



1998



1999

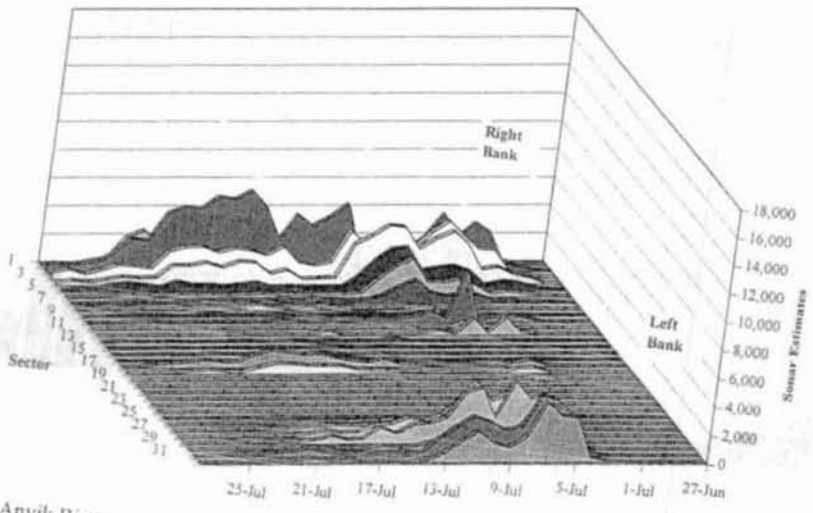


Figure 12. Daily Anvik River corrected sonar estimates by sector and day, 1997-1999. Note that the 1998 estimates include some pink salmon after 12 July.

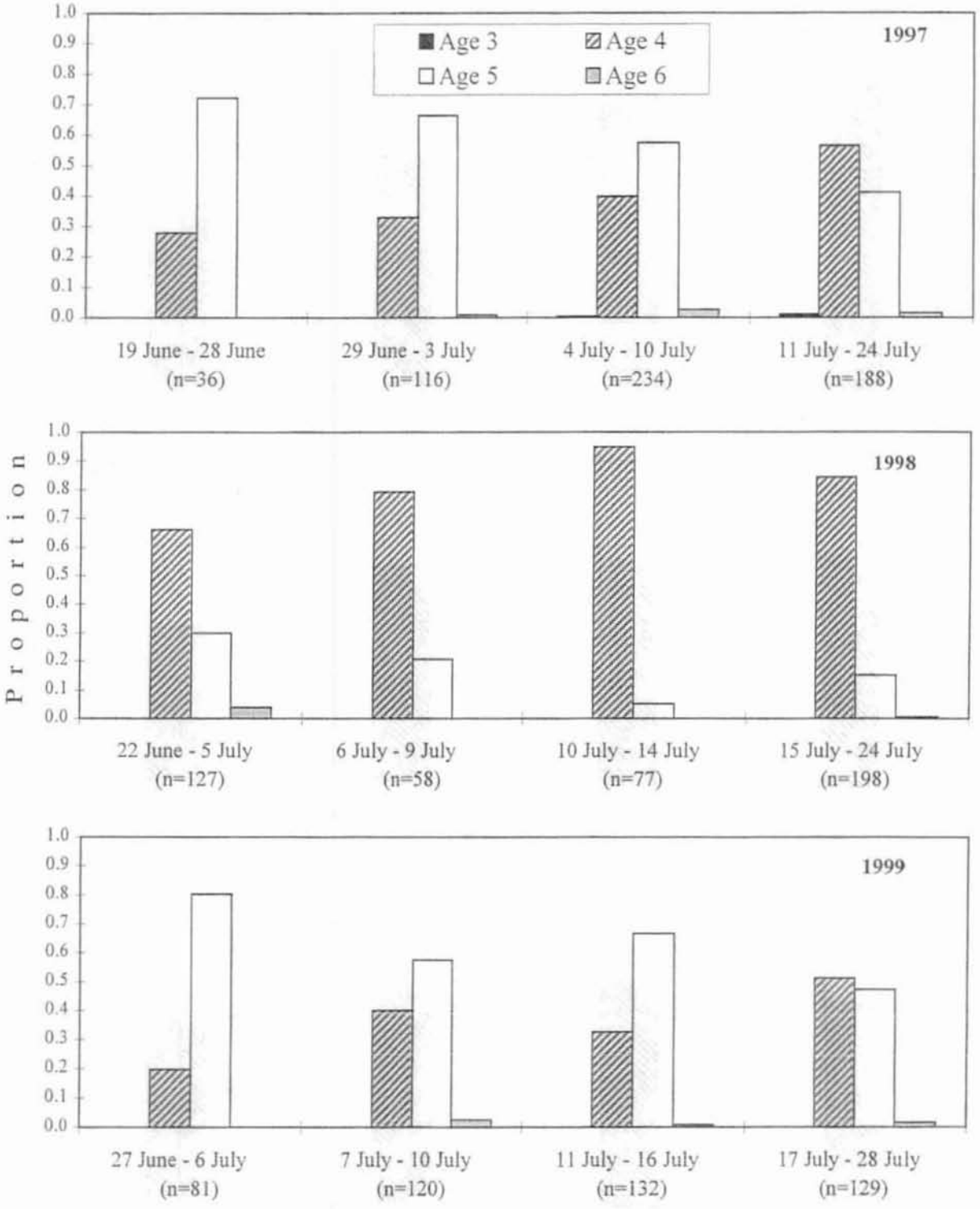


Figure 13. Age composition of Anvik River chum salmon by quartile, based on passage dates for each year, 1997-1999.

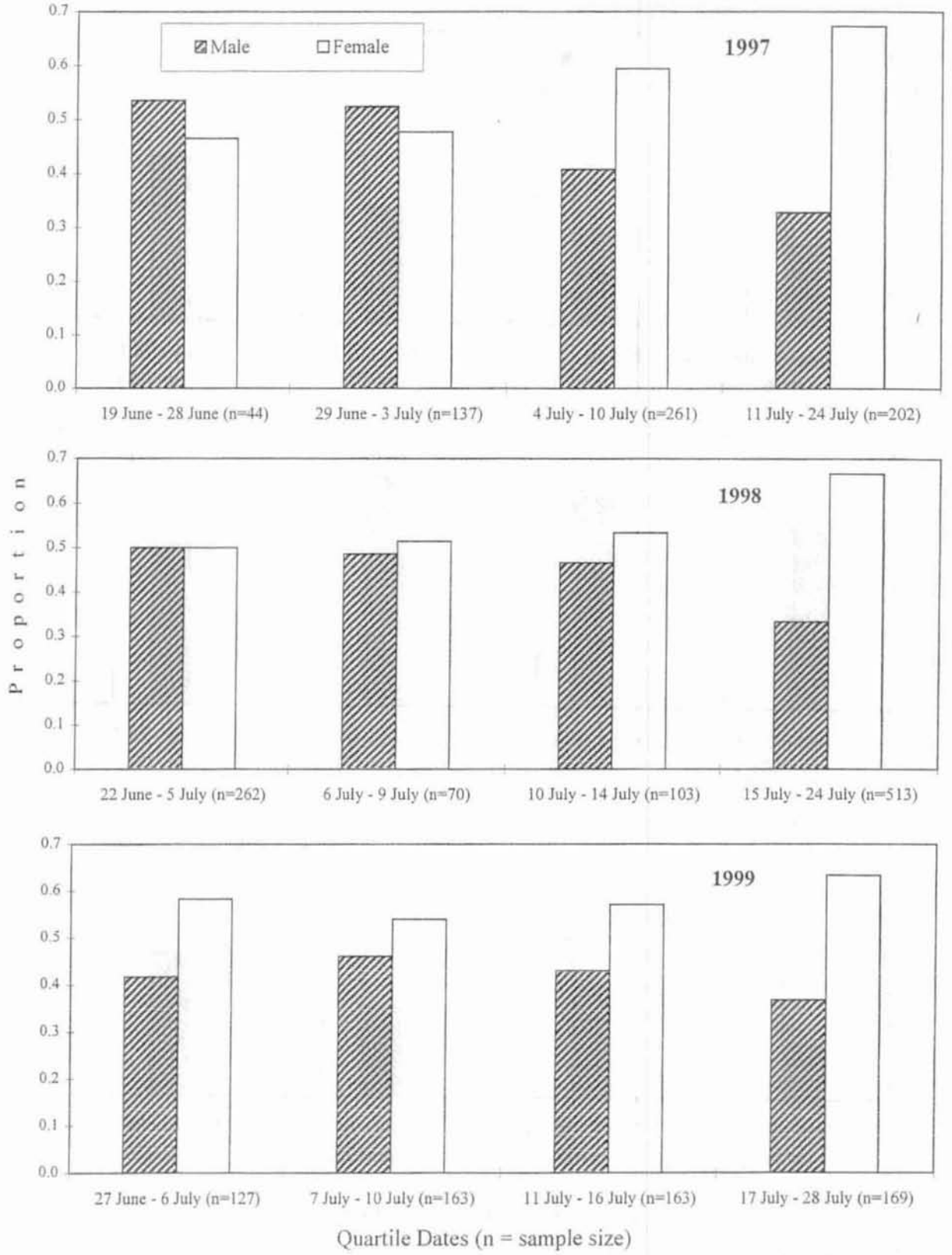
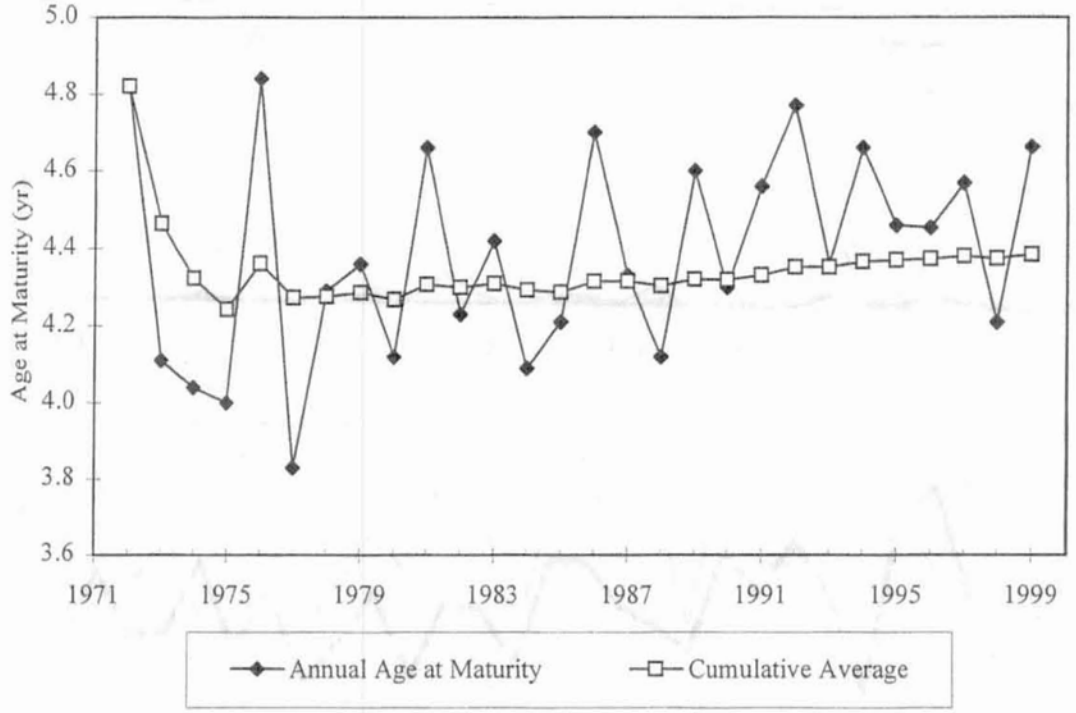


Figure 14. Sex composition of Anvik River chum salmon by quartile, based on passage dates for each year, 1997-1999.



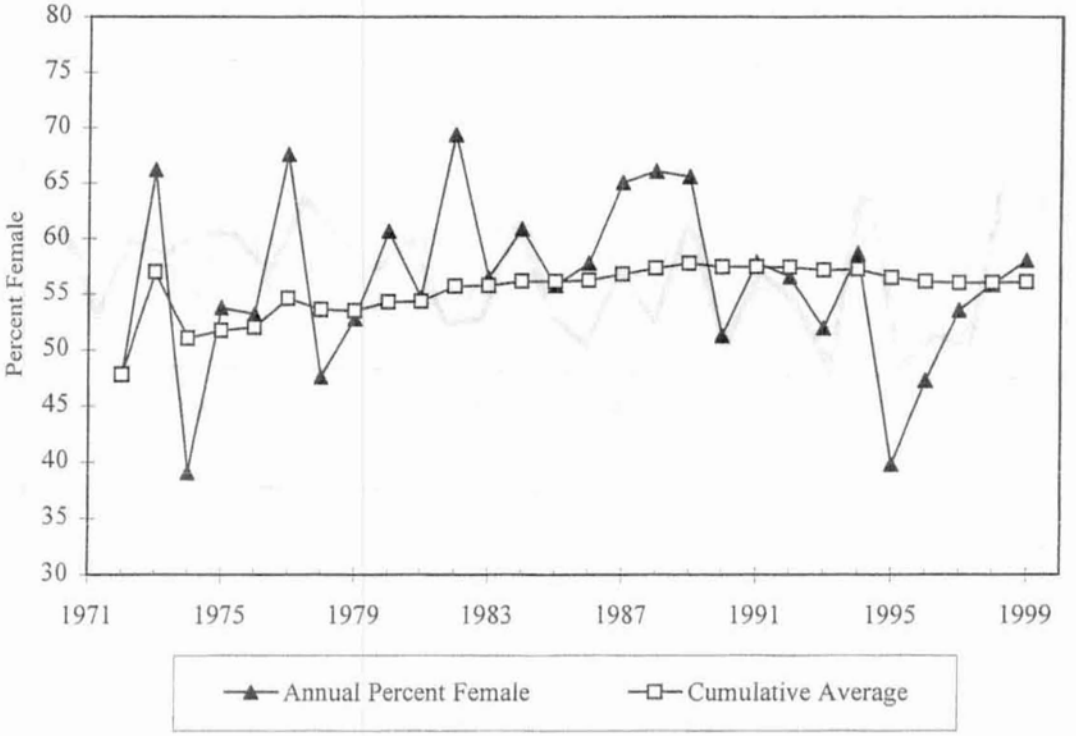


Figure 15. Annual age at maturity (top) and percentage of females (bottom) of the Anvik River chum salmon escapement, 1972-1999.

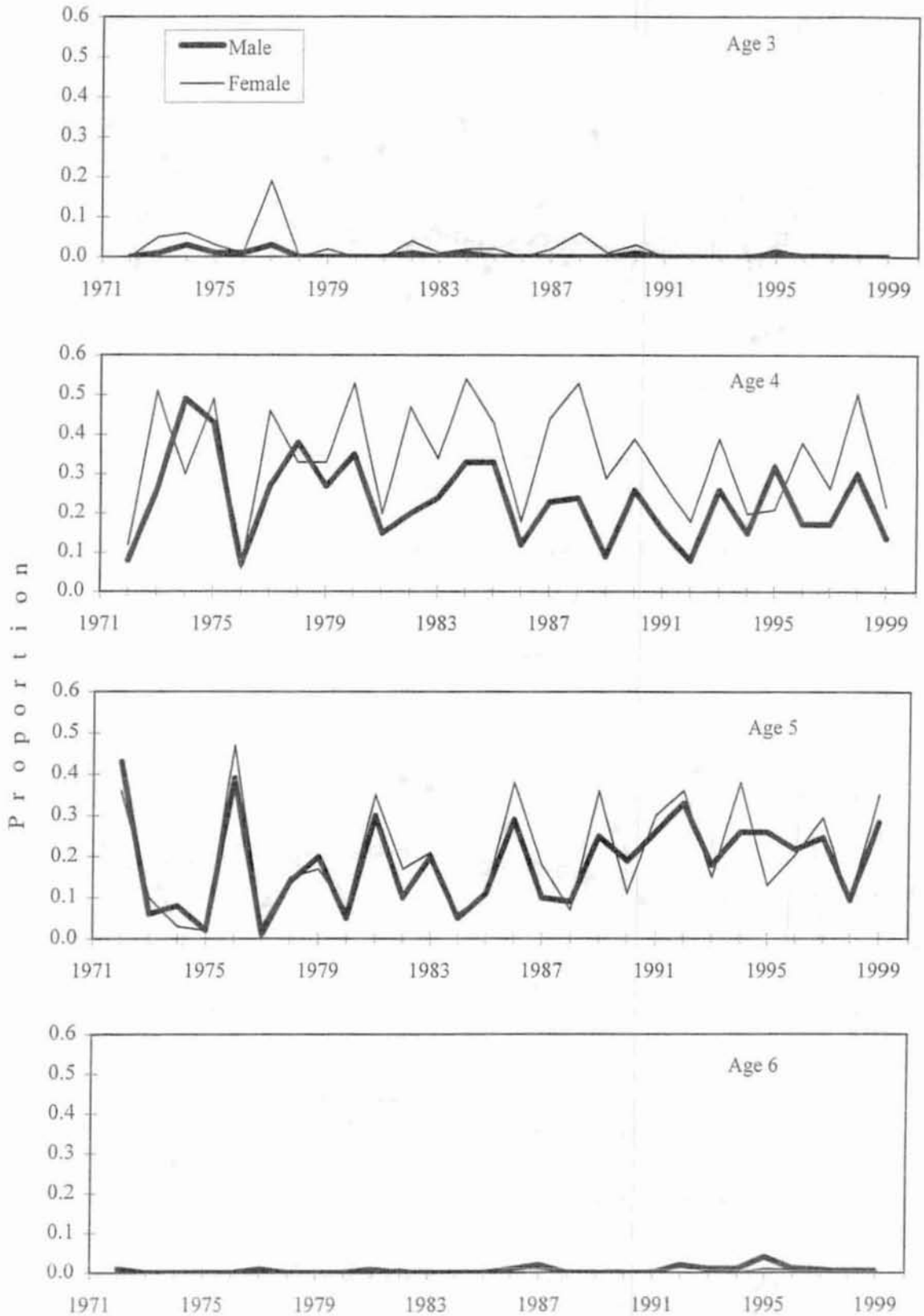


Figure 16. Annual age and sex composition of the Anvik River chum salmon escapement, 1972-1999.

APPENDIX

APPENDIX A: ANVIK RIVER CLIMATOLOGICAL AND HYDROLOGIC OBSERVATIONS

Appendix A.1. Climatological and hydrologic observations made at the Anvik River sonar site, 1997.

Date	Time	Precipitation (code) [a]	Wind (direction - velocity)	Sky (code) [b]	Temperature (°C)			Water Gauge			Water color (code) [c]	Remarks
					Air Min.	Air Max.	Water (Instanta-neous)	Actual (ft)	Relative (ft)	Relative (cm)		
19-Jun	10:30	I	S	3	9.0	18.0	11.0	1.30	0.00	0.0	Lt	Water gauge set at 1.30 ft. Light rain.
20-Jun	17:30	O	NNW	3	6.0	13.0	11.0	1.38	0.08	2.4	Lt	
21-Jun	19:30	O	NNW	3	3.0	16.0	11.0	1.44	0.14	4.3	Lt	
22-Jun	19:30	O	N - 10	1	7.5	15.0	12.0	1.23	-0.07	-2.1	Lt	
23-Jun	19:20	O	N - 10	1	5.0	22.0	15.0	1.11	-0.19	-5.8	Lt	
24-Jun	19:30	O	N - 10	1	15.0	25.0	16.5	1.00	-0.30	-9.1	Lt	
25-Jun	18:00	I	N - 10	3	15.0	25.0	19.0	0.90	-0.40	-12.2	Lt	
26-Jun	18:45	O	N - 5	1	10.0	21.0	12.0	0.90	-0.40	-12.2	Lt	Reset water gauge to 1.93 ft. after observation.
27-Jun	19:45	O		1	5.0	21.5	17.0	1.90	-0.43	-13.1	Lt	
28-Jun												No observation made.
29-Jun	18:57	O	S - 5	2	6.0	26.0	17.0	1.71	-0.62	-18.9	Lt	
30-Jun	18:51	O	N - 3	3	13.0	22.0	19.0	1.68	-0.65	-19.8	Lt	
01-Jul	18:33	I	N - 1	3	14.0	22.0	18.5	1.62	-0.71	-21.6	Lt	
02-Jul	18:44	I	N - 5	3	12.0	29.5	19.0	1.63	-0.70	-21.3	Lt	
03-Jul	18:37	O	S - 2	2	10.0	25.0	18.5	1.63	-0.70	-21.3	Lt	
04-Jul	21:29	O	S - 8	1	13.5	18.5	19.5	1.60	-0.73	-22.3	Lt	
05-Jul	19:23	O	N - 5	1	13.0	26.0	19.0	1.52	-0.81	-24.7	Lt	
06-Jul	21:51	O	NNW - 15	1	12.0	26.0	19.0	1.45	-0.88	-26.8	Lt	
07-Jul	18:47	O	NNW - 2	2	8.5	25.5	20.0	1.41	-0.92	-28.0	Lt	
08-Jul	18:49	I	S - 10	4	12.0	18.0	17.0	1.37	-0.96	-29.3	Lt	
09-Jul	19:03	O	S - 10	3	10.0	17.0	16.0	1.35	-0.98	-29.9	Lt	
10-Jul	18:48	I	W - 5	2	9.0	14.0	17.0	1.36	-0.97	-29.6	Lt	
11-Jul	18:35	O	W - 7	3	-1.0	11.0	11.0	1.37	-0.96	-29.3	Lt	Frost, some ice.
12-Jul	18:57	I	N - 3	4	2.0	14.0	13.0	1.37	-0.96	-29.3	Lt	
13-Jul	19:01	I	N - 10	3	3.0	13.0	13.0	1.32	-1.01	-30.8	Lt	
14-Jul	18:54	O	S - 15	3	6.0	16.5	14.0	1.34	-0.99	-30.2	Lt	Reset water gauge to 1.93 ft. after observation.
15-Jul	19:05	O	S - 5	2	4.0	21.0	14.0	1.83	-1.09	-33.2	Lt	
16-Jul	19:10	O	Variable - 10	2	3.0	21.5	15.0	1.84	-1.08	-32.9	Lt	Smokey.
17-Jul	19:02	O	S - 10	3	8.5	20.0	15.5	1.81	-1.11	-33.8	Lt	Smokey.
18-Jul	18:21	O	N - 5	2	5.0	22.0	11.0	1.77	-1.15	-35.1	Lt	
19-Jul	20:04	O	E - 7	2	11.0	24.0	11.0	1.73	-1.19	-36.3	Lt	
20-Jul	18:34	I	Calm	4	9.0	16.0	15.0	1.73	-1.19	-36.3	Lt	Bear destroyed water gauge at 12:53. Reset to 1.72 ft.
21-Jul	20:00	I	N - 2	3	8.0	21.0	15.5	1.71	-1.21	-36.9	Lt	
22-Jul	18:47	O	S - 8	2	8.5	25.0	12.5	1.70	-1.22	-37.2	Lt	
23-Jul	18:57	O	N - 10	2	9.0	22.0	18.0	1.73	-1.19	-36.3	Lt	
24-Jul	18:41	O	S - 10	1	9.0	21.0	13.0	1.69	-1.23	-37.5	Lt	
Mean					8.4	20.4	15.3			-23.3		

[a] Precipitation code: O = No precipitation; I = Intermittent rain; R = Continuous rain; S = Snow; S&R = Snow and rain mixed; H = Hail; and T = Thunder showers.

[b] Instantaneous sky code: 1 = Clear sky, cloud cover less than 10%; 2 = Cloud cover less than 50%; 3 = Cloud cover between 50% and 100%; 4 = Completely overcast; and 5 = Fog or thick haze.

[c] Instantaneous water color code: Cl = Clear; Lt = Light brown; Br = Brown; Dk = Dark brown; and Tr = Turbid: murky or glacial.

Appendix A.2. Climatological and hydrologic observations made at the Anvik River sonar site, 1998.

Date	Time	Precipitation (code) [a]	Wind (direction - velocity)	Sky (code) [b]	Temperature (°C)			Water Gauge			Water color (code) [c]	Remarks
					Air Min.	Air Max.	Water (Instantaneous)	Actual (ft)	Relative (ft)	Relative (cm)		
19-Jun	18:00	I	E- 5	3	12.0	13.0	11.0	1.54	0.00	0.0	Tr	Water gauge set at 1.54 ft. Water level high & rising.
20-Jun	19:00	I	E- 5	4	4.5	8.0	8.5	1.44	-0.05	-1.5	Tr	Water rose, then fell. Cold day.
21-Jun	18:00	I	E- 5	4	5.0	13.0	9.5	1.10	-0.39	-11.9	Tr	Heavy rain all night. Water still dropping fast.
22-Jun	19:00	O	Calm	2	5.0	17.0	10.0	1.12	-0.37	-11.3	Tr	Water clearing slowly.
23-Jun	19:00	O	S - 10	3	7.0	17.0	10.5	1.75	0.18	5.5	Tr	Water gauge hit. 1.20 ft. before = 1.12 ft. after?
24-Jun	19:00	O	W - 5	1	7.0	18.0	12.0	1.42	-0.15	-4.6	Tr	
25-Jun	19:00	O	N - 5	1	5.5	17.5	8.5	1.34	-0.23	-7.0	Tr	
26-Jun	19:00	O	W - 2	2	8.0	20.0	11.0	1.08	-0.49	-14.9	Tr	
27-Jun	19:00	O	SSE - 5	2	7.0	22.0	14.0	0.93	-0.64	-19.5	Tr	
28-Jun	18:45	O	NNW - 2	2	8.0	19.0	13.5	2.30	-0.72	-21.9	Br	Reset gauge from 0.85 ft. to 2.30 ft. before observation.
29-Jun	19:00	O	Calm	2	8.0	21.0	14.0	2.27	-0.75	-22.9	Br	
30-Jun	17:00	O	N - 2	1	9.0	24.0	10.5	2.15	-0.87	-26.5	Br	
01-Jul	18:00	O	Calm	3	8.0	18.0	12.5	2.00	-1.02	-31.1	Br	
02-Jul	19:00	I		3	8.0	11.0	12.0	1.92	-1.10	-33.5	Br	Rained hard until 14:00.
03-Jul	18:00	O			11.0	18.0	13.5	1.91	-1.11	-33.8	Br	
04-Jul	18:00	T	Calm	3	11.0	18.0	12.0	1.84	-1.18	-36.0	Br	Downpour from 17:00 to 18:00.
05-Jul	18:00	O	S - 2	2	8.0	21.0	12.0	1.83	-1.19	-36.3	Br	
06-Jul	18:00	O	S - 5	3	12.0	21.0	15.5	1.78	-1.24	-37.8	Br	AM hot & sunny; PM cloudy. River profile done.
07-Jul	18:00	R	S - 2	4	10.0	14.0	13.0	1.92	-1.10	-33.5	Br	Very heavy rain from 9:30 to 17:00.
08-Jul	19:00	R	S - 2	4	11.0	14.0	11.0	2.96	-0.06	-1.8	Tr	
09-Jul	18:00	R	S - 2	4	9.5	12.0	10.5	2.70	-0.32	-9.8	Tr	Heavy Rain. Gauge reset at 7:15 from 3.32 ft. to 1.98 ft.
10-Jul	18:00	O	N - 2	3	8.0	11.0	11.0	2.98	1.30	39.6	Dk	Highest water of the season.
11-Jul	18:00	O	N - 2	3	5.0	21.0	9.5	2.05	0.37	11.3	Tr	
12-Jul	18:00	O	N - 5	1	5.0	20.5	13.0	1.47	-0.21	-6.4	Tr	
13-Jul	18:00	O	S - 2	2	5.0	19.0	13.5	2.09	-0.61	-18.6	Br	Gauge reset at 16:00 from 1.10 ft. to 2.12 ft.
14-Jul	18:00	O	S - 2	3	10.0	17.0	12.0	1.70	-1.00	-30.5	Br	
15-Jul	18:00	O	N - 5	3	13.0	18.0	12.0	1.70	-1.00	-30.5	Br	
16-Jul	20:30	O	S - 5	2	7.0	22.0	14.0	1.57	-1.13	-34.4	Br	Sunny day; water dropping fast.
17-Jul	19:30	O		1	7.0	22.0	14.0	1.46	-1.24	-37.8	Br	
18-Jul	18:00	O		1	12.0	22.0	14.0	1.22	-1.48	-45.1	Lt	
19-Jul	19:00	I	N - 10	2	13.0	20.0	14.5	1.13	-1.57	-47.9	Lt	
20-Jul	19:00	I	E - 5	3	11.0	21.5	13.5	2.00	-1.48	-45.1	Lt	Heavy rain. Gauge reset at 12:00 from 1.22 ft. to 2.00 ft.
21-Jul	19:00	O	N - 5	1	9.0	25.0	16.0	1.95	-1.53	-46.6	Lt	Very hot day.
22-Jul	20:30	I	Calm	4	11.0	22.0	14.5	1.81	-1.67	-50.9	Lt	
23-Jul	19:00	O	S - 5	3	11.5	21.5	14.5	1.73	-1.75	-53.3	Lt	
Mean					8.6	18.3	12.3			-22.5		

[a] Precipitation code: O = No precipitation; I = Intermittent rain; R = Continuous rain; S = Snow; S&R = Snow and rain mixed; H = Hail; and T = Thunder showers.

[b] Instantaneous sky code: 1 = Clear sky, cloud cover less than 10%; 2 = Cloud cover less than 50%; 3 = Cloud cover between 50% and 100%; 4 = Completely overcast; and 5 = Fog or thick haze.

[c] Instantaneous water color code: Cl = Clear; Lt = Light brown; Br = Brown; Dk = Dark brown; and Tr = Turbid: murky or glacial.

[d] Does not include 10 July, when sonar was not in operation.

Appendix A.3. Climatological and hydrologic observations made at the Anvik River sonar site, 1999.

Date	Time	Precipitation (code/amt.) [a]	Wind (direction - velocity)	Sky (code) [b]	Temperature (°C)			Water Gauge			Water color (code) [c]	Remarks
					Air Min.	Air Max.	Water (Instanta-neous)	Actual (ft)	Relative (ft)	Relative (cm)		
23-Jun	16:00	I	Calm	3	15.0	20.0		1.70	0.00	0.0	Lt	Set water gauge at 1.7 ft. Water thermometer broken.
24-Jun	16:00	I	NE - 10	2	10.0	20.0		1.50	-0.20	-6.1	Lt	Gusty winds in PM.
25-Jun	16:00	O	SW - 5	2	18.0	22.0		1.60	-0.10	-3.0	Lt	Sunny & warm.
26-Jun	16:00	O	SW -10	3	16.0	25.0	15.0	1.30	-0.40	-12.2	Lt	Thunderheads. New water thermometer. River profile done.
27-Jun	16:00	O	Var. - Lt.	2	11.0	23.0	15.0	1.50	-0.20	-6.1	Lt	Water clearing.
28-Jun	16:00	T	Var. - 15	3	15.0	25.0	17.0	1.10	-0.60	-18.3	Lt	T-storm at 13:30 w/ high winds, lightning, no rain.
29-Jun	23:00	O	Calm	1	15.0	23.0	14.0	1.10	-0.60	-18.3	Lt	Late reading.
30-Jun	17:00	O	Calm	3	9.0	21.0	16.0	0.90	-0.80	-24.4	Cl	
01-Jul	19:00	O	Gusty	3	11.0	23.0	16.0	0.65	-1.05	-32.0	Cl	Winds calm in AM, gusty evening.
02-Jul	16:00	O	Gusty	4	10.0	19.0	14.0	0.50	-1.20	-36.6	Cl	
03-Jul	17:20	O	Breezy	1	6.0	20.0	15.0	0.45	-1.25	-38.1	Cl	Reset water gauge to 1.8 ft. after observation.
04-Jul	15:30	O	Calm	1	8.0	21.0	15.0	1.60	-1.45	-44.2	Cl	
05-Jul	15:43	O	Calm	1	2.0	23.0	16.0	1.45	-1.60	-48.8	Cl	Cool night, warm day.
06-Jul	17:50	O	N - Gusty	1	2.0	23.0	17.0	1.30	-1.75	-53.3	Cl	Cool breeze, very nice.
07-Jul	16:45	O	N - Gusty	1	1.0	21.0	17.0	1.25	-1.80	-54.9	Lt	Water a bit turbid today.
08-Jul	16:30	O	Calm	1	6.0	20.0	17.0	1.10	-1.95	-59.4	Lt	Water turbid.
09-Jul												No observation made.
10-Jul	16:15	O	Gusty	1	14.0	26.0	18.0	0.90	-2.15	-65.5	Lt	Thunderstorms in the area.
11-Jul	16:05	I	Gusty	2	10.0	25.0	19.0	0.90	-2.15	-65.5	Lt	Fog in AM, storm in PM.
12-Jul	14:55	O	Calm	3	11.0	23.0	18.0	0.90	-2.15	-65.5	Lt	
13-Jul	17:33	O	N - Gusty	3	15.0	23.0	18.0	0.80	-2.25	-68.6	Lt	Storm clouds in the area.
14-Jul	16:15	I	Calm	4	10.0	21.0	14.5	0.70	-2.35	-71.6	Lt	Overcast, rain on and off after 13:00.
15-Jul	19:00	I	Gusty	1	14.0	18.0	14.0	0.70	-2.35	-71.6	Cl	
16-Jul	19:00	I	N - Gusty	3	10.0	18.0	14.0	0.75	-2.30	-70.1	Cl	Reset water gauge to 1.5 ft. after obs. Intermittent rain all day.
17-Jul	19:00	I	Gusty	3	10.0	18.0	14.0	1.50	-2.30	-70.1	Cl	Intermittent rain until 18:00.
18-Jul	17:50	I	Calm	4	4.0	17.0		1.47	-2.33	-71.0	Cl	
19-Jul	16:30	I	Calm	4	10.0	15.0	12.0	1.40	-2.40	-73.2	Cl	Intermittent light rain.
20-Jul	18:30	I	Gusts to 30	4	8.0	10.0	11.0	1.80	-2.00	-61.0	Lt	Windy all night & all day. Water rising fast in PM.
21-Jul	16:30	I	W - 20	3	7.0	11.0	10.0	2.30	-1.50	-45.7	Lt	Reset H_2O gauge to 2.4 ft. after obs. Hi. winds, lt. rain. H_2O rising.
22-Jul	18:30	O	Calm	1	0.0	12.0	11.0	2.20	-1.70	-51.8	Lt	Frost last night. Water clearing.
23-Jul	16:00	O	Calm	4	9.0	16.0	12.0	2.00	-1.90	-57.9	Lt	Low stratus clouds.
24-Jul	15:18	O	Calm	3	13.0	20.0	13.0	1.90	-2.00	-61.0	Cl	
25-Jul	18:30	I	Gusty	4	10.0	19.0	14.0	2.00	-1.90	-57.9	Cl	
26-Jul	18:40	I	Calm	4	8.0	11.0	12.0	2.10	-1.80	-54.9	Cl	
27-Jul	18:30	I	Calm	1	6.0	18.0	13.0	2.30	-1.60	-48.8	Cl	
28-Jul	14:20	O	Calm	4	4.0	13.0	11.0	2.45	-1.45	-44.2	Cl	
Mean					9.4	19.5	14.6			-46.6		

[a] Precipitation code: O = No precipitation; I = Intermittent rain; R = Continuous rain; S = Snow; S&R = Snow and rain mixed; H = Hail; and T = Thunder showers.

[b] Instantaneous sky code: 1 = Clear sky, cloud cover less than 10%; 2 = Cloud cover less than 50%; 3 = Cloud cover between 50% and 100%; 4 = Completely overcast; and 5 = Fog or thick haze.

[c] Instantaneous water color code: Cl = Clear; Lt = Light brown; Br = Brown; Dk = Dark brown; and Tr = Turbid: murky or glacial.

APPENDIX B: ANVIK RIVER SONAR CALIBRATION AND VISUAL OBSERVATION DATA

Appendix B 1. Daily summary of sonar calibrations and visual salmon counts from towers, Anvik River, 1997.

	Right Bank								Left Bank							
	Sonar Calibrations				Visual Counts				Sonar Calibrations				Visual Counts			
	Elapsed				Elapsed	Net Upstream			Elapsed				Elapsed	Net Upstream		
	Time	Sonar	Scope	Sonar/	Time [a]	Salmon Passage			Time	Sonar	Scope	Sonar/	Time [a]	Salmon Passage		
Date	(hrs:min)	Count	Count	Scope	(hrs:min)	Chum	Chinook	Pink	(hrs:min)	Count	Count	Scope	(hrs:min)	Chum	Chinook	Pink
19-Jun	0:45	77	67	1.15	0:00				0:30	0	0		0:00			
20-Jun	1:25	236	298	0.79	0:00				1:00	0	0		0:00			
21-Jun	1:25	372	360	1.03	0:00				1:00	0	0		0:15	0	0	0
22-Jun	1:25	241	261	0.92	0:30	Data not recorded.			1:00	0	0		0:00			
23-Jun	1:48	671	617	1.09	0:00				0:41	296	300	0.99	0:00			
24-Jun	2:08	594	528	1.13	0:15	57	0	0	0:38	381	358	1.06	0:00			
25-Jun	1:15	203	190	1.07	0:00				0:54	557	504	1.11	0:00			
26-Jun	1:00	131	124	1.06	0:00				1:20	254	214	1.19	0:00			
27-Jun	1:24	545	572	0.95	0:45	311	0	0	0:50	243	243	1.00	0:00			
28-Jun	0:55	330	337	0.98	0:00				0:41	339	327	1.04	0:11	7	0	0
29-Jun	0:52	241	248	0.97	0:00				0:50	564	513	1.10	0:00			
30-Jun	1:00	219	221	0.99	0:00				0:39	370	355	1.04	0:00			
1-Jul	0:51	286	301	0.95	0:00				0:28	428	427	1.00	0:00			
2-Jul	0:58	432	458	0.94	0:00				0:32	403	403	1.00	0:00			
3-Jul	0:58	404	394	1.03	0:00				1:01	491	506	0.97	0:00			
4-Jul	0:56	327	346	0.95	0:00				0:25	314	302	1.04	0:00			
5-Jul	1:11	595	552	1.08	0:20	124	10	0	0:42	523	501	1.04	0:05	65	1	0
6-Jul	1:00	429	420	1.02	0:00				0:54	363	362	1.00	0:17	107	0	0
7-Jul	0:51	362	348	1.04	0:00				0:47	330	377	0.88	0:10	101	1	0
8-Jul	1:07	515	463	1.11	0:00				0:43	375	374	1.00	0:00			
9-Jul	1:09	305	308	0.99	0:10	28	0	0	1:29	455	411	1.11	0:00			
10-Jul	1:14	398	359	1.11	0:10	16	8	0	0:54	293	271	1.08	0:00			
11-Jul	1:14	276	249	1.11	0:00				1:11	282	271	1.04	0:15	15	0	0
12-Jul	1:10	239	221	1.08	0:10	10	-1	0	1:00	105	106	0.99	0:00			
13-Jul	1:10	203	189	1.07	0:10	10	0	0	1:15	140	126	1.11	0:10	8	0	0
14-Jul	1:15	335	302	1.11	0:00				0:57	206	200	1.03	0:00			
15-Jul	0:55	235	237	0.99	0:00				1:30	343	340	1.01	0:15	41	1	0
16-Jul	1:00	293	306	0.96	0:10	28	1	0	1:25	404	386	1.05	0:00			
17-Jul	1:32	466	443	1.05	0:25	98	4	0	1:22	310	335	0.93	0:10	9	0	0
18-Jul	1:00	297	291	1.02	0:00				1:12	242	249	0.97	0:00			
19-Jul	1:39	454	442	1.03	0:00				1:06	304	306	0.99	0:00			
20-Jul	1:15	404	291	1.39	0:15	64	0	0	1:15	273	256	1.07	0:00			
21-Jul	1:00	376	239	1.57	0:00				1:15	330	298	1.11	0:00			
22-Jul	0:55	455	235	1.94	0:15	15	0	0	1:55	422	359	1.18	0:15	55	0	1
23-Jul	0:15	70	40	1.75	1:30	223	12	0	1:45	209	234	0.89	0:15	4	0	0
24-Jul	0:00				1:20	113	-6	0	1:00	122	127	0.96	0:00			
Total	39:57	12,016	11,257		6:15	1,097	28	0	36:06	10,671	10,341		2:18	412	3	1
Mean	1:08			1.10					1:00			1.03				

[a] Some visual tower counts were concurrent with sonar calibrations.

Appendix B.2. Daily summary of sonar calibrations and visual salmon counts from towers, Anvik River, 1998.

	Right Bank								Left Bank							
	Sonar Calibrations				Visual Counts				Sonar Calibrations				Visual Counts			
	Elapsed				Elapsed	Net Upstream			Elapsed				Elapsed	Net Upstream		
	Time	Sonar	Scope	Sonar/	Time [a]	Salmon Passage			Time	Sonar	Scope	Sonar/	Time [a]	Salmon Passage		
Date	(hrs:min)	Count	Count	Scope	(hrs:min)	Chum	Chinook	Pink	(hrs:min)	Count	Count	Scope	(hrs:min)	Chum	Chinook	Pink
21-Jun	0:45	0	0		0:00				0:00				0:00			
22-Jun	1:55	20	15	1.33	0:30	0	0	0	0:00				0:00			
23-Jun	1:30	62	55	1.13	0:15	0	0	0	0:00				0:00			
24-Jun	1:15	123	128	0.96	0:00				0:00				0:00			
25-Jun	0:56	131	142	0.92	0:00				0:30	0	0		0:00			
26-Jun	1:15	212	210	1.01	0:00				1:30	74	38	1.95	0:00			
27-Jun	1:15	230	201	1.14	0:00				1:00	17	13	1.31	0:00			
28-Jun	1:39	168	204	0.82	0:09	15	0	0	1:00	18	16	1.13	0:00			
29-Jun	1:15	159	169	0.94	0:15	27	0	0	1:00	6	6	1.00	0:00			
30-Jun	1:36	281	294	0.96	0:21	57	0	0	1:30	66	54	1.22	0:15	0	0	0
1-Jul	0:50	412	401	1.03	0:00				1:15	61	51	1.20	0:00			
2-Jul	0:56	482	481	1.00	0:10	99	0	0	1:00	18	21	0.86	0:15	15	0	0
3-Jul	0:42	579	593	0.98	0:09	100	0	0	1:30	30	41	0.73	0:15	3	0	0
4-Jul	0:11	211	200	1.06	0:00				0:45	45	37	1.22	0:00			
5-Jul	0:26	378	400	0.95	0:10	100	0	0	1:00	41	44	0.93	0:00			
6-Jul	0:32	526	500	1.05	0:08	93	0	0	1:00	162	146	1.11	0:00			
7-Jul	0:35	522	501	1.04	0:00				0:45	87	73	1.19	0:00			
8-Jul	0:57	402	404	1.00	0:00				1:15	100	95	1.05	0:00			
9-Jul	0:45	259	251	1.03	0:00				0:00				0:00			
10-Jul	0:00				0:00				0:00				0:00			
11-Jul	0:36	401	401	1.00	0:00				0:00				0:00			
12-Jul	0:29	472	501	0.94	1:18	1,541	1	188	0:00				0:00			
13-Jul	0:30	406	401	1.01	0:15	66	0	13	0:00				0:00			
14-Jul	0:55	520	508	1.02	0:00				0:00				0:00			
15-Jul	0:59	485	492	0.99	1:20	252	0	271	1:30	286	291	0.98	0:30	25	0	56
16-Jul	0:40	533	501	1.06	0:45	279	0	168	1:00	580	435	1.33	0:45	126	2	112
17-Jul	1:03	617	590	1.05	0:30	125	0	75	1:24	412	403	1.02	0:30	130	1	220
18-Jul	1:10	511	539	0.95	0:45	260	0	143	1:00	241	231	1.04	0:30	91	0	135
19-Jul	0:56	661	598	1.11	0:28	161	-1	108	1:00	474	461	1.03	0:30	136	0	284
20-Jul	0:56	644	610	1.06	0:34	145	0	223	0:54	385	403	0.96	0:30	54	0	134
21-Jul	0:47	402	387	1.04	0:55	194	1	157	1:03	410	422	0.97	0:50	124	0	213
22-Jul	0:56	476	494	0.96	0:35	131	0	205	1:21	552	513	1.08	0:30	62	0	188
23-Jul	0:50	363	380	0.96	0:32	78	1	125	1:30	340	343	0.99	0:40	17	0	151
24-Jul	0:15	78	76	1.03	0:20	53	1	72	0:15	83	99	0.84	0:15	14	0	76
Total	29:41	11,726	11,627		10:24	3,776	3	1,748	25:57	4,488	4,236		6:15	797	3	1,569
Mean	0:55 [b]			1.02					1:04 [b]			1.09				

[a] Some visual tower counts were concurrent with sonar calibrations.

[b] Only includes days of sonar operation.

Appendix B.3. Daily summary of sonar calibrations and visual salmon counts from towers, Anvik River, 1999.

	Right Bank								Left Bank							
	Sonar Calibrations				Visual Counts				Sonar Calibrations				Visual Counts			
	Elapsed				Elapsed	Net Upstream			Elapsed				Elapsed	Net Upstream		
	Time	Sonar	Scope	Sonar/	Time [a]	Salmon Passage			Time	Sonar	Scope	Sonar/	Time [a]	Salmon Passage		
Date	(hrs:min)	Count	Count	Scope	(hrs:min)	Chum	Chinook	Pink	(hrs:min)	Count	Count	Scope	(hrs:min)	Chum	Chinook	Pink
27-Jun	0:45	0	0		0:00				0:45	0	0		0:15	2	0	0
28-Jun	1:00	7	7	1.00	0:00				1:00	3	3	1.00	0:00			
29-Jun	0:45	5	6	0.83	0:00				0:45	1	1	1.00	0:00			
30-Jun	1:15	77	65	1.18	0:45	99	0	0	1:00	4	4	1.00	0:00			
1-Jul	1:19	787	721	1.09	0:40	258	2	0	1:15	35	51	0.69	0:00			
2-Jul	0:40	256	265	0.97	0:00				1:00	6	8	0.75	0:15	0	0	0
3-Jul	0:55	392	394	0.99	0:00				1:15	80	77	1.04	0:45	7	0	0
4-Jul	0:52	511	469	1.09	0:00				2:00	24	12	2.00	0:45	99	0	0
5-Jul	0:34	433	425	1.02	0:00				1:02	255	249	1.02	1:07	493	0	0
6-Jul	1:20	610	542	1.13	0:20	99	0	0	1:21	598	659	0.91	0:28	166	0	0
7-Jul	0:55	456	468	0.97	0:15	61	2	0	1:25	436	363	1.20	0:30	59	0	0
8-Jul	0:39	410	375	1.09	0:15	63	1	0	1:15	319	340	0.94	0:15	12	0	0
9-Jul	0:59	349	336	1.04	0:30	43	2	0	1:25	484	303	1.60	1:35	58	0	0
10-Jul	0:57	455	436	1.04	0:30	136	0	0	0:55	208	195	1.07	0:15	10	0	0
11-Jul	1:20	537	489	1.10	0:25	82	0	0	1:20	543	328	1.66	0:25	81	0	0
12-Jul	1:19	574	489	1.17	0:15	43	0	0	1:00	357	324	1.10	0:15	37	0	0
13-Jul	1:22	443	422	1.05	0:15	50	0	0	0:55	248	233	1.06	0:25	77	0	0
14-Jul	1:17	384	340	1.13	0:00				1:00	113	107	1.06	0:15	3	0	0
15-Jul	1:11	429	373	1.15	0:15	0	0	0	1:15	155	142	1.09	0:00			
16-Jul	0:52	414	375	1.10	0:15	0	0	0	1:15	165	175	0.94	0:15	7	0	0
17-Jul	0:48	346	324	1.07	0:00				1:00	97	89	1.09	0:15	0	0	0
18-Jul	0:52	386	360	1.07	0:15	0	0	0	1:00	133	125	1.06	0:30	35	0	0
19-Jul	0:45	282	266	1.06	0:00				0:45	48	50	0.96	0:00			
20-Jul	0:55	411	390	1.05	0:00				1:00	118	115	1.03	0:00			
21-Jul	1:10	263	288	0.91	0:10	-4	-1	0	1:00	63	67	0.94	0:15	12	0	0
22-Jul	1:10	395	354	1.12	0:10	21	0	0	1:00	35	35	1.00	0:15	0	0	0
23-Jul	1:15	289	292	0.99	0:15	37	0	0	1:00	61	56	1.09	0:15	10	0	0
24-Jul	1:00	188	196	0.96	0:20	14	0	0	1:00	96	89	1.08	0:15	0	0	0
25-Jul	1:15	147	152	0.97	0:15	19	0	0	1:00	36	36	1.00	0:15	7	0	0
26-Jul	1:00	84	84	1.00	0:00				1:00	17	19	0.89	0:15	2	0	0
27-Jul	0:55	60	57	1.05	0:10	6	0	0	0:45	3	3	1.00	0:15	0	0	0
28-Jul	1:00	48	45	1.07	0:00	0	0	0	0:45	6	6	1.00	0:15	0	0	0
Total	32:21	10,428	9,805		6:00	1,027	6	0	36:28	4,747	4,264		10:35	1,177	0	0
Mean	1:00			1.05					1:04			1.07				

a Most visual tower counts were concurrent with sonar calibrations.

APPENDIX C: ANVIK RIVER RIGHT BANK TEMPORAL SONAR ESTIMATE DATA

Appendix C.1. Right bank Anvik River corrected sonar estimates by hour and day, 19 June - 24 July, 1997.

Hour	19-Jun [a]	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul
0000 - 0100		33	126	210	581	710	323	202	149	244	220	856	295	619	752	668	448	412
0100 - 0200		363	302	331	937	1,168	426	456	293	496	516	509	478	603	880	682	439	557
0200 - 0300		443	428	458	1,034	1,419	376	458	377	596	571	661	380	597	604	510	502	620
0300 - 0400		539	381	585	1,035	1,048	642	412	502	653	441	521	518	707	554	477	568	488
0400 - 0500		551	1,197	648	649	742	521	439	559	470	487	573	504	576	815	479	814	632
0500 - 0600		1,044	2,059	503	557	550	262	371	585	602	437	303	516	630	783	413	607	564
0600 - 0700		785	921	461	393	403	145	183	463	426	254	160	411	340	451	529	423	453
0700 - 0800		189	471	385	875	599	74	151	562	402	172	146	303	267	267	391	376	448
0800 - 0900		85	233	256	1,055	438	94	130	345	272	118	93	193	270	223	243	274	467
0900 - 1000		112	216	218	730	301	66	23	410	528	173	133	222	229	135	217	183	318
1000 - 1100		22	153	67	592	272	78	47	306	705	207	116	117	258	240	142	222	243
1100 - 1200		6	174	40	434	201	132	22	370	635	166	167	97	291	268	243	202	240
1200 - 1300		4	198	35	339	74	72	43	288	505	174	235	193	398	353	424	318	327
1300 - 1400		7	162	40	373	146	81	19	273	295	174	184	208	236	370	512	430	356
1400 - 1500		8	153	20	148	203	109	33	304	415	188	232	286	341	319	413	418	225
1500 - 1600		14	164	35	287	169	75	37	360	363	337	295	341	437	352	373	512	287
1600 - 1700	140	16	79	32	193	153	154	85	364	456	190	297	295	473	335	418	373	269
1700 - 1800	141	5	78	37	124	68	238	129	375	675	168	189	267	523	330	428	360	223
1800 - 1900	102	19	72	29	73	59	255	152	465	586	193	151	234	627	289	394	420	483
1900 - 2000	97	26	56	14	257	290	265	228	670	392	215	120	292	319	292	406	338	242
2000 - 2100	42	41	42	18	231	182	147	183	688	344	306	284	439	236	194	371	367	279
2100 - 2200	16	42	63	35	227	192	226	221	427	142	295	225	258	319	322	454	409	280
2200 - 2300	19	59	58	143	213	105	192	142	164	164	262	315	197	278	229	380	323	284
2300 - 2400	17	143	119	281	536	177	198	101	140	232	876	653	363	219	518	222	280	438
Total	574	4,554	7,905	4,880	11,873	9,669	5,152	4,266	9,437	10,597	7,142	7,416	7,408	9,794	9,877	9,787	9,607	9,135

continued

Appendix C.1. (page 2 of 2) Right bank Anvik River corrected sonar estimates by hour and day, 19 June - 24 July, 1997.

Hour	7-Jul	8-Jul	9-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul [b]	24-Jul
0000 - 0100	684	538	422	363	395	218	148	309	416	455	250	484	303	395	385	303	156	
0100 - 0200	441	561	486	326	313	196	119	224	482	495	180	263	268	311	241	204	151	
0200 - 0300	571	451	685	353	250	175	127	193	129	434	172	219	138	243	183	132	69	
0300 - 0400	372	361	457	145	145	143	123	216	255	458	284	164	104	229	138	224	134	
0400 - 0500	532	791	460	177	208	195	49	198	232	499	232	140	199	190	128	370	294	
0500 - 0600	349	645	629	320	319	162	115	304	248	544	298	361	249	243	186	304	110	
0600 - 0700	381	454	586	314	324	275	152	284	327	337	272	411	305	345	192	304	165	
0700 - 0800	444	443	315	374	210	267	147	134	337	335	305	165	221	286	240	421	105	
0800 - 0900	416	455	176	243	235	173	143	234	282	228	234	186	308	224	271	160	140	
0900 - 1000	194	466	192	228	167	170	92	248	238	293	349	151	130	308	163	91	88	
1000 - 1100	306	469	235	192	140	148	58	207	246	203	306	166	109	229	199	66	34	
1100 - 1200	297	559	278	151	126	90	89	166	180	127	179	104	100	543	163	79		
1200 - 1300	399	469	223	151	111	102	61	187	173	159	108	126	113	448	141	77		
1300 - 1400	537	297	241	228	96	72	109	156	159	137	152	67	144	241	215	81		
1400 - 1500	396	322	182	186	169	132	78	103	122	136	213	82	161	225	253	127		
1500 - 1600	231	323	186	306	118	121	66	142	89	125	143	89	84	212	289	293		
1600 - 1700	195	355	252	229	158	131	89	106	99	163	135	108	90	243	274	366		
1700 - 1800	158	323	249	211	123	92	94	166	101	128	142	85	168	198	296	383		
1800 - 1900	313	444	169	234	149	144	159	194	84	180	156	205	624	221	317	216		
1900 - 2000	123	313	217	170	112	98	177	181	128	173	146	178	624	251	323	187		
2000 - 2100	163	329	298	187	118	106	142	164	102	184	190	224	395	276	221	151		
2100 - 2200	122	436	469	243	136	164	148	169	99	245	224	248	353	299	283	224		
2200 - 2300	178	507	372	220	216	207	161	165	237	243	306	304	362	449	331	111		
2300 - 2400	440	510	400	375	261	146	223	328	342	234	421	414	449	349	372	133		
Total	8,242	10,820	8,179	5,924	4,599	3,727	2,867	4,781	5,106	6,513	5,397	4,945	6,000	6,957	5,806	5,005	1,445	

a Right bank sonar counting began at 15:00 on 19 June.

b Right bank sonar counting terminated at 10:35 on 23 July.

Appendix C.2. Right bank Anvik River corrected sonar estimates by hour and day, 22 June - 24 July, 1998.

Hour	22-Jun[a]	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul	7-Jul	8-Jul
0000 - 0100		54	48	130	116	375	366	92	234	474	530	1,084	1,111	1,228	1,737	1,286	759
0100 - 0200		47	69	137	176	220	480	171	351	584	715	1,431	1,039	817	1,406	1,376	839
0200 - 0300		140	116	231	210	418	368	287	361	603	873	1,054	937	743	1,603	1,425	1,040
0300 - 0400		134	104	304	309	379	315	249	465	568	915	789	1,043	1,073	1,705	1,399	794
0400 - 0500		84	144	178	249	381	286	318	464	671	908	1,072	1,077	1,168	1,411	1,455	821
0500 - 0600		91	144	156	209	244	235	306	398	811	480	1,440	1,042	1,260	1,352	1,474	892
0600 - 0700		85	79	293	137	247	294	200	359	680	755	1,719	1,196	1,043	1,040	1,586	727
0700 - 0800		80	86	177	188	265	394	210	353	673	573	1,451	1,001	932	1,021	1,544	966
0800 - 0900		34	151	138	165	312	220	176	265	753	471	1,183	1,045	703	1,063	1,363	835
0900 - 1000		27	148	201	200	217	122	102	153	599	410	885	1,024	842	1,219	1,342	1,027
1000 - 1100		17	113	147	155	74	129	136	159	478	512	804	839	750	1,396	1,076	992
1100 - 1200		13	101	198	180	172	173	109	102	379	581	1,063	700	828	1,220	1,109	991
1200 - 1300	18	0	117	45	75	103	70	122	148	445	326	1,018	654	867	917	1,336	642
1300 - 1400	6	0	4	102	58	64	91	103	143	381	349	828	645	903	1,047	1,391	327
1400 - 1500	3	0	7	78	71	39	46	51	194	482	392	703	489	795	1,090	1,249	114
1500 - 1600	4	0	29	38	52	50	45	87	158	378	332	554	598	725	1,415	1,147	220
1600 - 1700	1	0	14	24	37	114	69	78	106	443	372	511	701	648	929	1,168	194
1700 - 1800	3	0	3	37	37	100	76	83	124	398	431	454	737	743	876	1,176	188
1800 - 1900	13	12	6	90	70	117	39	66	235	386	479	659	770	764	980	1,200	214
1900 - 2000	6	47	26	24	108	68	28	116	169	502	704	734	738	1,214	948	1,052	300
2000 - 2100	9	38	42	44	128	96	28	186	155	672	763	779	941	1,187	1,014	1,240	397
2100 - 2200	7	34	89	38	185	117	46	274	462	441	800	898	842	1,095	1,173	1,262	481
2200 - 2300	34	59	197	70	200	97	93	245	592	490	762	864	866	1,282	1,228	1,277	471
2300 - 2400	33	62	222	67	198	185	124	256	541	545	835	1,126	1,115	1,541	1,206	1,273	424
Total	137	1,057	2,059	2,946	3,510	4,452	4,138	4,023	6,690	12,838	14,268	23,102	21,150	23,151	28,997	31,206	14,653

continued

Appendix C.2. (page 2 of 2) Right bank Anvik River corrected sonar estimates by hour and day, 22 June - 24 July, 1998.

Hour	9-Jul [b,c]	10-Jul	11-Jul [d]	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul [e]
0000 - 0100	715			1,304	1,321	796	589	1,031	1,174	568	1,423	1,006	722	747	618	513
0100 - 0200	597			1,839	1,668	1,094	550	1,085	1,286	633	1,308	978	721	679	662	531
0200 - 0300	565			1,405	1,574	1,044	746	898	1,546	609	1,048	926	651	710	689	539
0300 - 0400	592			1,350	1,713	978	708	1,027	1,417	496	1,031	944	664	747	667	472
0400 - 0500	649			1,488	1,709	1,022	629	1,016	1,629	451	1,062	913	695	653	626	509
0500 - 0600	727			1,233	1,765	1,032	766	1,168	1,513	493	1,199	1,123	731	615	781	542
0600 - 0700	724			732	1,341	944	721	924	1,056	422	869	904	722	723	728	517
0700 - 0800	684			760	1,307	820	558	733	869	346	751	1,425	779	623	586	460
0800 - 0900	705			665	937	640	588	591	880	393	936	1,184	517	641	648	398
0900 - 1000	706			616	890	656	438	602	755	345	891	1,095	383	731	652	402
1000 - 1100	662			649	975	617	557	682	872	237	883	1,412	528	662	640	373
1100 - 1200	564			579	692	616	553	733	743	310	854	1,338	387	504	596	395
1200 - 1300	678			951	718	534	501	661	223	338	541	1,265	387	429	415	155
1300 - 1400	491		785	1,458	634	479	428	858	350	367	490	699	290	662	415	
1400 - 1500	362		1,154	1,204	690	454	329	892	398	354	573	491	366	437	453	
1500 - 1600	397		1,522	1,084	867	429	357	800	394	364	720	535	386	463	533	
1600 - 1700	356		1,228	1,249	888	386	406	808	354	352	743	626	347	594	494	
1700 - 1800	326		895	1,113	926	479	424	545	384	395	731	544	255	600	483	
1800 - 1900	268		817	1,011	814	497	329	714	313	342	735	667	274	623	417	
1900 - 2000	71		829	968	800	432	372	813	374	460	838	452	265	816	374	
2000 - 2100			802	1,030	913	370	717	724	347	1,053	888	452	383	817	436	
2100 - 2200			806	1,022	1,069	361	602	950	344	972	735	372	381	755	558	
2200 - 2300			924	1,133	1,194	445	682	907	423	1,199	813	553	502	771	569	
2300 - 2400			881	1,318	1,070	586	1,029	1,185	479	1,373	852	810	834	770	653	
Total	10,839		10,643	26,158	26,474	15,710	13,579	20,347	18,125	12,871	20,914	20,714	12,170	15,773	13,695	5,805

a Right bank sonar counting began at 00:00.

b Due to flooding, right bank sonar counting terminated at 19:00.

c First pink salmon sighted. Corrected sonar estimatess for 9 July - 24 July include pink salmon.

d Right bank sonar counting resumed at 13:00.

e Right bank sonar counting terminated at 12:30.

Appendix C.3. Right bank Anvik River corrected sonar estimates by hour and day, 27 June - 28 July, 1999.

Hour	27-Jun[a]	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul	7-Jul	8-Jul	9-Jul	10-Jul	11-Jul	12-Jul
0000 - 0100	1	1	48	82	89	628	784	965	932	727	1,218	857	915	1,195	572	545
0100 - 0200	2	1	104	83	245	978	553	1,004	1,161	444	635	695	1,395	1,485	769	599
0200 - 0300	10	0	96	96	191	922	558	969	756	363	487	660	1,198	1,158	367	379
0300 - 0400	20	4	79	80	184	585	722	1,100	614	374	591	563	918	923	325	317
0400 - 0500	16	0	120	48	260	560	706	1,133	534	609	667	1,012	1,269	1,108	374	337
0500 - 0600	27	0	94	118	377	460	599	1,062	487	535	707	913	1,271	1,046	409	112
0600 - 0700	0	0	34	196	375	372	390	971	607	628	971	705	513	918	321	335
0700 - 0800	0	2	44	229	256	183	333	681	657	394	792	613	280	758	234	201
0800 - 0900	0	16	51	139	275	227	471	410	978	369	610	518	274	509	308	138
0900 - 1000	0	7	55	140	352	163	376	438	1,135	318	808	458	260	402	336	153
1000 - 1100	0	2	48	159	347	117	339	579	966	269	595	319	226	398	327	165
1100 - 1200	0	14	64	194	414	96	399	643	1,926	1,002	644	313	217	354	432	186
1200 - 1300	0	18	73	111	514	200	125	460	1,308	419	529	326	105	779	347	505
1300 - 1400	0	5	51	40	470	85	403	609	1,272	291	470	311	98	301	479	239
1400 - 1500	0	38	64	222	329	135	447	521	731	269	726	251	290	435	346	318
1500 - 1600	0	29	54	194	440	175	395	594	638	301	918	293	214	428	287	344
1600 - 1700	1	24	25	231	337	135	280	623	478	373	636	511	194	309	282	556
1700 - 1800	0	3	24	168	293	139	353	296	433	334	840	371	192	280	267	234
1800 - 1900	0	3	39	153	432	331	596	564	674	528	767	717	56	311	353	233
1900 - 2000	4	16	70	76	462	741	536	818	988	451	749	657	201	316	296	222
2000 - 2100	1	13	59	44	622	724	969	932	742	449	660	650	336	324	274	240
2100 - 2200	0	12	31	43	856	882	1,255	962	370	223	918	688	325	403	429	285
2200 - 2300	1	20	73	64	750	815	1,093	1,034	549	151	427	634	337	447	244	287
2300 - 2400	0	10	77	85	679	846	1,207	688	420	246	258	591	473	404	275	290
Total	83	238	1,477	2,997	9,551	10,499	13,888	18,055	19,358	10,067	16,621	13,625	11,558	14,988	8,654	7,218

continued

Appendix C.3. (page 2 of 2) Right bank Anvik River corrected sonar estimates by hour and day, 27 June - 28 July, 1999.

Hour	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul	28-Jul[b]
0000 - 0100	534	629	384	266	765	673	632	605	312	342	345	354	103	99	54	179
0100 - 0200	399	812	616	567	923	650	544	488	382	265	295	246	108	41	33	124
0200 - 0300	437	700	492	847	768	499	572	465	297	167	244	210	93	69	42	103
0300 - 0400	489	389	255	665	533	350	567	623	311	197	187	174	275	37	56	66
0400 - 0500	572	390	298	534	519	316	630	510	425	211	197	264	223	55	43	35
0500 - 0600	468	402	361	628	676	466	451	501	373	199	323	192	207	86	21	48
0600 - 0700	562	400	555	881	833	585	439	534	340	411	394	277	248	94	40	29
0700 - 0800	396	272	438	508	420	422	408	357	383	300	247	205	175	70	115	30
0800 - 0900	261	206	287	679	248	343	285	293	437	234	408	183	189	54	16	45
0900 - 1000	350	343	360	362	383	407	449	337	517	229	331	134	203	48	29	27
1000 - 1100	330	258	312	270	445	493	473	304	630	183	247	126	31	168	19	46
1100 - 1200	237	282	367	254	396	449	307	380	750	277	156	159	78	79	40	56
1200 - 1300	264	295	281	269	288	252	422	266	769	299	320	242	110	159	95	67
1300 - 1400	235	320	387	420	357	386	305	286	826	295	206	110	106	57	104	77
1400 - 1500	237	200	295	598	507	391	422	331	808	195	198	162	85	46	258	86
1500 - 1600	393	254	445	578	494	340	402	497	516	411	247	275	111	89	164	106
1600 - 1700	373	183	735	606	494	446	350	324	700	417	282	341	91	64	157	121
1700 - 1800	321	209	487	519	419	411	553	416	527	235	282	208	164	26	158	189
1800 - 1900	262	172	373	579	372	402	399	430	307	382	342	164	157	41	153	51
1900 - 2000	217	171	259	559	350	505	426	542	190	214	292	134	119	55	110	32
2000 - 2100	176	337	408	554	382	383	416	649	190	133	237	249	127	106	146	14
2100 - 2200	257	380	301	590	271	441	458	644	167	202	212	167	84	117	140	46
2200 - 2300	254	415	291	484	541	569	455	229	169	424	338	160	119	87	172	65
2300 - 2400	204	332	235	411	569	461	432	264	240	339	410	145	123	51	183	87
Total	8,228	8,353	9,222	12,628	11,953	10,642	10,798	10,272	10,565	6,560	6,740	4,880	3,331	1,798	2,348	1,728

a Right bank sonar counting began at 00:00 on 27 June.

b Right bank sonar counting terminated at 24:00 on 28 July.

Appendix D.1. (page 2 of 2) Left bank Anvik River corrected sonar estimates by hour and day, 19 June - 24 July, 1997.

Hour	7-Jul	8-Jul	9-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul [b]
0000 - 0100	563	399	291	424	559	412	76	140	214	513	519	540	762	606	286	380	288	319
0100 - 0200	483	406	253	330	534	330	112	44	501	565	599	592	957	534	507	586	289	208
0200 - 0300	294	604	230	208	437	349	109	47	488	452	533	447	534	278	263	395	121	92
0300 - 0400	502	714	126	119	300	154	91	29	377	484	379	278	388	274	260	205	94	63
0400 - 0500	344	472	241	65	260	164	65	43	360	381	452	201	293	168	159	117	121	49
0500 - 0600	663	710	196	78	210	115	84	29	284	355	316	175	269	113	107	137	110	41
0600 - 0700	272	644	273	145	162	91	69	33	219	250	294	171	175	169	152	164	117	65
0700 - 0800	140	535	112	223	111	102	39	66	129	184	262	74	106	107	175	90	98	41
0800 - 0900	366	448	51	178	72	62	24	68	83	209	194	47	84	114	132	63	23	28
0900 - 1000	149	462	51	184	72	59	22	65	129	272	282	65	98	117	179	77	29	13
1000 - 1100	442	329	93	145	73	148	38	57	103	247	251	63	104	164	289	60	27	34
1100 - 1200	490	368	162	282	54	73	50	70	99	235	177	97	104	308	238	76	51	56
1200 - 1300	671	504	227	185	79	288	45	128	177	146	217	328	135	205	167	82	61	88
1300 - 1400	574	735	159	175	177	219	52	148	275	331	123	236	169	174	164	89	46	190
1400 - 1500	649	580	207	185	210	381	56	149	268	284	126	231	212	130	202	78	38	200
1500 - 1600	891	788	272	299	315	102	69	111	144	208	122	240	140	177	224	80	53	107
1600 - 1700	999	767	472	301	299	126	89	149	176	375	201	214	208	208	224	223	60	165
1700 - 1800	1,129	562	572	475	354	116	77	216	227	503	254	351	233	208	224	219	105	294
1800 - 1900	1,116	591	536	516	472	147	158	164	390	490	238	440	519	242	224	218	179	97
1900 - 2000	1,089	744	663	427	503	109	102	262	416	539	249	527	532	167	224	368	189	165
2000 - 2100	1,169	443	813	465	469	92	77	316	469	601	344	695	478	264	256	437	397	246
2100 - 2200	1,358	396	700	592	328	121	206	413	590	711	368	759	613	346	377	538	286	216
2200 - 2300	1,385	219	501	805	535	140	181	398	630	660	373	852	667	411	387	510	293	344
2300 - 2400	784	214	412	794	458	131	140	473	735	761	537	713	663	392	340	427	248	295
Total	16,522	12,636	7,612	7,600	7,041	4,030	2,031	3,617	7,484	9,757	7,408	8,337	8,443	5,874	5,764	5,619	3,321	3,415

a Left bank sonar counting began at 18:00 on 19 June.

b Left bank sonar counting terminated at 24:00 on 24 July.

Appendix D.2. Left bank Anvik River corrected sonar estimates by hour and day, 22 June - 24 July, 1998.

Hour	22-Jun	23-Jun	24-Jun	25-Jun[a]	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul	7-Jul	8-Jul
0000 - 0100					0	0	19	21	53	86	36	40	77	56	163	317	158
0100 - 0200					0	0	25	11	71	195	17	59	70	227	123	161	108
0200 - 0300					0	0	25	38	46	157	11	46	62	149	134	158	102
0300 - 0400					0	0	25	47	98	114	25	32	83	62	247	228	81
0400 - 0500					0	0	25	69	30	90	22	39	157	144	311	485	96
0500 - 0600					0	0	25	33	22	79	5	81	53	115	157	543	154
0600 - 0700					0	4	29	50	22	64	2	47	65	20	75	487	53
0700 - 0800					25	3	39	45	49	116	18	59	67	14	119	145	103
0800 - 0900					26	7	48	47	54	64	1	80	121	29	147	179	139
0900 - 1000					22	11	36	48	70	143	20	28	67	49	109	164	125
1000 - 1100					14	5	41	10	114	60	10	153	40	75	63	186	134
1100 - 1200					18	0	1	15	83	96	8	56	44	51	172	146	146
1200 - 1300					0	0	1	0	10	53	3	41	57	24	152	185	56
1300 - 1400				5	0	0	3	0	9	120	31	48	41	13	250	134	16
1400 - 1500				16	0	0	0	0	4	7	3	44	48	60	157	149	113
1500 - 1600				8	0	0	3	0	7	21	4	167	113	74	95	74	89
1600 - 1700				6	0	0	0	0	4	7	8	36	114	86	247	84	81
1700 - 1800				3	0	0	0	0	35	13	2	20	115	57	423	114	149
1800 - 1900				22	0	4	0	0	73	19	13	8	151	279	279	69	97
1900 - 2000				14	16	7	0	83	92	53	47	40	155	179	310	80	107
2000 - 2100				11	34	5	0	106	105	55	80	43	100	168	481	404	102
2100 - 2200				36	16	31	1	112	46	43	76	108	39	93	376	99	47
2200 - 2300				27	32	37	3	61	152	11	83	134	73	149	379	60	34
2300 - 2400				27	53	55	8	65	148	19	76	120	116	82	296	75	34
Total				175	256	169	357	861	1,396	1,687	600	1,529	2,028	2,256	5,263	4,724	2,324

continued

APPENDIX D: ANVIK RIVER LEFT BANK TEMPORAL SONAR ESTIMATE DATA

Appendix D.1. Left bank Anvik River corrected sonar estimates by hour and day, 19 June - 24 July, 1997.

Hour	19-Jun [a]	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul
0000 - 0100		0	3	0	2	1,081	653	439	261	1,102	1,795	1,106	1,159	1,098	867	530	1,120	846
0100 - 0200		0	1	1	16	694	705	411	237	750	1,123	659	898	645	685	411	923	360
0200 - 0300		0	28	10	16	500	672	193	534	526	982	667	764	603	725	440	960	145
0300 - 0400		6	19	8	24	415	910	224	492	620	1,314	766	706	493	737	625	799	214
0400 - 0500		4	43	2	4	685	1,033	262	607	514	1,398	809	517	619	590	577	455	174
0500 - 0600		8	17	1	1	538	1,206	259	574	683	1,227	1,117	655	517	604	475	661	343
0600 - 0700		2	14	4	2	783	881	248	328	575	1,352	796	813	500	673	423	699	247
0700 - 0800		0	6	0	0	782	802	56	71	553	497	891	769	419	481	558	788	328
0800 - 0900		1	4	0	0	1,246	859	26	63	625	1,108	940	965	441	531	681	792	387
0900 - 1000		0	1	0	1	1,349	951	73	140	514	1,152	638	957	339	462	798	1,205	270
1000 - 1100		0	1	0	1	1,546	863	47	60	269	1,198	657	767	433	364	1,083	705	436
1100 - 1200		0	3	0	0	1,496	1,009	29	62	85	1,078	443	945	539	407	1,021	739	464
1200 - 1300		0	2	0	0	1,010	1,030	18	23	29	707	376	688	847	582	546	620	446
1300 - 1400		0	3	0	0	736	1,100	30	38	54	613	359	1,033	939	523	535	498	322
1400 - 1500		0	2	0	0	815	1,015	27	25	19	402	456	1,147	801	657	656	374	412
1500 - 1600		0	1	0	588	350	593	46	21	6	371	804	1,010	595	1,132	1,019	362	509
1600 - 1700		0	0	0	605	439	764	7	22	15	465	595	1,430	568	1,338	1,302	633	576
1700 - 1800		0	0	0	706	616	582	10	57	45	998	1,432	1,665	804	1,175	892	614	686
1800 - 1900	4	0	0	0	943	800	510	34	265	747	1,787	1,956	1,919	768	1,234	780	439	570
1900 - 2000	2	0	10	1	1,181	592	332	15	571	2,221	2,819	1,870	1,270	1,393	1,320	523	559	702
2000 - 2100	1	2	17	15	1,217	557	429	89	1,050	2,588	2,710	1,670	1,211	1,845	1,188	654	692	632
2100 - 2200	2	1	32	15	1,413	704	488	158	1,623	2,526	2,529	1,633	1,360	1,505	1,229	924	446	621
2200 - 2300	4	20	10	15	1,331	1,144	611	242	1,897	2,167	2,312	1,308	1,244	1,578	1,053	1,346	837	775
2300 - 2400	11	0	4	15	1,410	1,107	495	330	1,412	1,843	1,535	1,071	1,393	1,604	647	1,255	829	497
Total	24	44	221	87	9,461	19,984	18,494	3,271	10,433	19,079	31,472	23,018	25,284	19,892	19,204	18,054	16,750	10,963

continued

Appendix D.2. (page 2 of 2) Left bank Anvik River corrected sonar estimates by hour and day, 22 June - 24 July, 1998.

Hour	9-Jul [b,c]	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul[d]	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul[e]
0000 - 0100								465	279	342	584	557	707	1,541	268	173
0100 - 0200								258	248	611	232	332	317	1,536	279	235
0200 - 0300								216	244	394	275	278	358	1,242	514	149
0300 - 0400								210	344	330	270	284	328	1,604	408	165
0400 - 0500								217	247	255	243	267	177	813	233	110
0500 - 0600								167	213	253	218	356	323	625	230	172
0600 - 0700								265	223	353	378	612	452	826	238	160
0700 - 0800								280	223	236	353	488	252	582	293	187
0800 - 0900								362	279	467	413	583	355	501	321	324
0900 - 1000							38	399	601	551	570	868	521	419	290	364
1000 - 1100							116	586	515	574	493	534	501	418	440	332
1100 - 1200							286	563	443	405	628	601	362	444	408	162
1200 - 1300							115	341	553	245	813	510	242	443	321	
1300 - 1400							207	423	540	282	490	274	288	55	318	
1400 - 1500							432	480	700	325	532	951	363	338	302	
1500 - 1600							467	643	459	174	415	447	384	335	333	
1600 - 1700							386	767	355	390	744	652	256	335	429	
1700 - 1800							458	511	314	496	527	369	612	335	260	
1800 - 1900							337	680	551	467	573	369	692	335	349	
1900 - 2000							424	789	600	653	594	352	612	328	343	
2000 - 2100							424	686	468	493	538	492	668	290	264	
2100 - 2200							424	686	423	523	640	865	678	287	282	
2200 - 2300							424	436	485	549	580	932	658	278	215	
2300 - 2400							85	243	285	344	601	503	491	330	225	
Total							4,622	10,671	9,590	9,714	11,705	12,476	10,598	14,241	7,560	2,533

a Left bank sonar counting began at 11:45 on 25 June.

b Due to flooding, left bank sonar counting terminated at 00:00 on 9 July.

c First pink salmon sighted. Sonar estimates 15 July - 24 July include pink salmon.

d Left bank sonar counting resumed at 09:00.

e Left bank sonar counting terminated at 11:30.

Appendix D.3. Left bank Anvik River corrected sonar estimates by hour and day, 27 June - 28 July, 1999.

Hour	27-Jun[a]	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul	7-Jul	8-Jul	9-Jul	10-Jul	11-Jul	12-Jul
0000 - 0100	0	0	8	2	16	73	136	85	125	1,212	2,177	743	779	288	1,132	401
0100 - 0200	0	0	4	9	8	17	74	126	156	1,115	1,406	593	479	744	834	705
0200 - 0300	0	8	19	27	12	95	152	370	316	1,690	1,842	843	499	593	1,699	660
0300 - 0400	0	2	2	19	9	36	184	764	412	1,148	1,531	1,088	550	732	1,401	567
0400 - 0500	0	0	1	14	8	88	314	216	481	855	1,118	795	589	943	881	740
0500 - 0600	0	0	1	12	19	34	140	214	374	461	1,728	895	568	876	543	646
0600 - 0700	0	3	1	9	1	87	288	133	394	370	498	853	194	646	426	487
0700 - 0800	0	1	8	12	8	6	172	15	406	337	659	697	172	685	506	253
0800 - 0900	0	0	0	18	3	39	40	1	411	585	760	592	131	579	654	192
0900 - 1000	0	1	3	5	1	3	20	1	430	865	606	279	135	610	614	354
1000 - 1100	0	1	0	0	0	18	78	3	462	733	428	216	185	323	419	215
1100 - 1200	0	0	0	0	1	15	6	0	466	376	453	111	165	260	527	88
1200 - 1300	0	0	1	0	0	3	3	0	468	317	221	163	244	221	619	179
1300 - 1400	1	2	0	0	0	0	3	28	469	225	300	309	338	467	344	208
1400 - 1500	0	7	0	0	0	0	3	2	480	290	162	295	280	649	491	252
1500 - 1600	0	0	0	0	0	1	0	5	492	281	214	328	104	444	341	301
1600 - 1700	0	0	0	0	8	0	0	1	356	236	223	292	133	325	246	172
1700 - 1800	0	0	0	0	19	2	1	4	196	284	226	618	241	380	278	353
1800 - 1900	0	0	2	0	46	4	10	88	224	604	165	419	315	425	294	280
1900 - 2000	0	0	8	0	43	0	31	3	291	938	12	630	408	552	194	364
2000 - 2100	0	1	0	11	32	15	41	10	403	1,213	583	993	424	773	455	422
2100 - 2200	0	1	9	15	26	53	26	156	524	1,383	361	753	571	981	431	589
2200 - 2300	1	0	0	26	122	58	98	122	1,624	1,374	1,059	963	1,208	1,040	549	544
2300 - 2400	0	9	2	41	127	99	192	316	1,460	1,115	1,329	1,013	1,376	1,423	483	610
Total	2	36	69	220	507	746	2,013	2,663	11,419	18,008	18,062	14,481	10,086	14,956	14,362	9,583

continued

Appendix D.3. (page 2 of 2) Left bank Anvik River corrected sonar estimates by hour and day, 27 June - 28 July, 1999.

Hour	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul	28-Jul[b]
0000 - 0100	539	281	168	252	117	91	126	94	83	68	62	50	72	30	6	21
0100 - 0200	750	380	146	147	155	85	109	116	186	69	125	67	44	30	14	20
0200 - 0300	332	543	98	166	180	101	143	167	140	76	75	70	83	40	15	23
0300 - 0400	360	375	37	106	162	105	141	102	76	53	105	59	123	16	19	6
0400 - 0500	491	329	126	59	46	112	81	86	105	63	72	30	58	12	10	14
0500 - 0600	240	329	193	156	103	149	111	54	74	69	92	17	55	6	3	12
0600 - 0700	281	441	186	162	262	97	118	219	77	71	73	90	32	20	7	8
0700 - 0800	218	495	229	300	204	128	154	151	88	135	140	70	66	37	12	10
0800 - 0900	190	259	120	152	60	125	138	147	92	62	46	63	37	70	9	15
0900 - 1000	252	178	148	328	142	145	118	161	138	118	69	69	81	13	7	6
1000 - 1100	246	86	120	205	132	43	185	94	206	147	56	85	66	44	35	6
1100 - 1200	189	123	150	133	44	28	285	186	93	103	98	39	55	26	10	1
1200 - 1300	111	107	135	185	97	112	143	71	47	44	144	54	40	43	12	8
1300 - 1400	134	33	112	153	103	122	115	107	66	55	131	54	58	23	2	2
1400 - 1500	148	100	76	309	98	189	110	165	92	70	140	96	32	25	58	12
1500 - 1600	104	90	78	335	125	163	249	122	125	82	73	61	17	12	11	15
1600 - 1700	102	71	79	283	156	273	179	137	78	74	130	42	64	24	11	7
1700 - 1800	329	114	68	264	91	154	229	175	71	85	32	24	65	17	16	25
1800 - 1900	383	135	169	157	91	164	289	96	111	49	30	35	58	60	22	
1900 - 2000	200	147	196	168	227	166	388	160	139	77	104	119	20	17	19	
2000 - 2100	307	83	387	267	135	169	306	164	79	88	44	54	23	40	19	
2100 - 2200	380	277	375	269	100	218	283	103	150	100	39	37	45	21	27	
2200 - 2300	548	240	176	198	135	233	193	141	109	61	27	74	43	20	27	
2300 - 2400	285	138	216	142	95	206	98	109	104	88	64	45	20	24	9	
Total	7,118	5,352	3,787	4,895	3,058	3,378	4,291	3,126	2,529	1,906	1,971	1,402	1,256	671	380	211

a Left bank sonar counting began at 00:00 on 27 June.

b Left bank sonar counting terminated at 18:30 on 28 July.

APPENDIX E: ANVIK RIVER RIGHT BANK SPATIAL SONAR ESTIMATE DATA

Appendix E.1. Right bank Anvik River corrected sonar estimates by sector and day, 19 June - 24 July, 1997.

Right Bank Sector	9-Jun[a]	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul
1	20	555	2,494	1,351	2,835	2,724	1,134	1,159	1,736	2,792	2,425	2,530	2,234	2,842	3,212	2,531	1,960	2,216
2	186	2,146	4,246	2,300	4,900	3,481	2,175	1,734	4,069	4,533	3,264	3,225	3,132	3,943	3,621	3,800	3,577	2,903
3	197	1,217	816	668	2,306	1,513	914	916	2,558	2,447	1,154	1,229	1,466	2,240	2,161	2,389	2,365	2,217
4	151	572	307	493	1,533	1,233	447	224	731	543	175	264	320	450	488	632	968	942
5	18	55	38	66	262	459	202	50	131	79	21	49	70	118	156	129	282	312
6	0	5	1	2	10	100	46	39	59	27	9	28	50	78	80	83	158	170
7	2	2	1	0	6	67	40	18	41	51	16	42	34	46	42	63	89	108
8	0	0	1	0	0	40	65	11	27	23	19	12	22	23	29	48	75	72
9	0	2	1	0	6	14	11	0	6	3	3	3	9	6	8	19	24	22
10	0	0	0	0	5	23	18	5	8	13	7	9	11	9	22	18	22	29
11	0	0	0	0	10	7	13	3	18	10	7	1	9	6	18	7	21	33
12	0	0	0	0	0	6	31	2	4	1	4	2	11	10	4	6	13	21
13	0	0	0	0	0	1	10	2	10	8	4	6	23	7	9	19	23	26
14	0	0	0	0	0	4	25	21	10	5	7	0	5	7	6	7	6	10
15	0	0	0	0	0	0	12	39	11	21	11	7	7	4	8	17	11	24
16	0	0	0	0	0	0	8	41	19	40	15	10	3	3	14	20	13	31
Total	574	4,554	7,905	4,880	11,873	9,669	5,152	4,266	9,437	10,597	7,142	7,416	7,408	9,794	9,877	9,787	9,607	9,135

continued

Appendix E.1. (page 2 of 2) Right bank Anvik River corrected sonar estimates by sector and day, 19 June - 24 July, 1997.

Right Bank Sector	7-Jul	8-Jul	9-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul[a]	24-Jul
1	1,064	1,478	1,095	646	783	596	398	364	346	384	365	180	218	2	3	6	1	
2	2,538	3,686	2,366	1,261	1,189	890	642	1,162	1,297	1,666	841	698	921	245	254	303	74	
3	2,725	3,723	2,891	1,983	1,272	840	666	1,424	1,590	2,255	1,985	1,786	2,020	1,822	1,668	998	226	
4	1,129	1,158	1,097	959	574	542	448	796	944	1,653	1,087	1,207	1,488	2,999	2,473	1,463	500	
5	314	274	260	341	189	164	170	244	189	226	321	317	384	793	651	691	199	
6	158	147	120	254	172	183	136	331	431	124	266	276	276	279	216	919	325	
7	82	68	92	119	54	78	50	68	60	58	98	96	148	243	128	411	50	
8	56	64	60	106	63	91	54	65	34	25	55	66	125	210	100	67	0	
9	23	21	11	27	16	16	23	19	13	16	29	39	70	68	65	30	10	
10	31	40	25	25	36	17	30	40	27	32	81	40	90	57	65	51	9	
11	33	42	28	54	58	44	64	70	46	24	72	68	72	15	15	11	14	
12	15	12	18	21	13	28	28	16	7	4	15	19	18	40	15	6	3	
13	23	31	19	37	29	36	31	27	18	8	34	33	34	68	38	15	3	
14	6	8	11	13	21	38	29	19	17	4	27	22	29	28	22	6	2	
15	18	22	24	15	27	29	29	67	14	14	50	40	34	21	19	9	2	
16	27	42	62	63	102	136	67	70	74	20	71	58	71	65	72	19	27	
Total	8,242	10,820	8,179	5,924	4,599	3,727	2,865	4,781	5,106	6,513	5,397	4,945	6,000	6,957	5,806	5,005	1,445	

a Right bank sonar counting began at 15:00 on 9 June.

b Right bank sonar counting terminated at 10:35 on 23 July.

Appendix E.2. Right bank Anvik River corrected sonar estimates by sector and day, 22 June - 24 July, 1998.

Right Bank Sector	22-Jun[a]	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul	7-Jul
1	6	16	72	64	64	3	39	56	353	1,302	2,173	5,693	4,674	4,793	7,120	5,279
2	18	249	283	413	391	30	343	755	2,338	6,062	6,862	11,877	10,521	11,186	14,843	17,194
3	19	403	288	482	359	134	379	1,524	2,178	3,730	3,666	3,536	4,227	5,005	5,071	6,453
4	18	236	428	554	446	600	573	1,017	1,028	1,273	1,082	1,191	1,169	1,375	1,226	1,449
5	17	62	295	416	502	702	690	457	419	330	322	549	385	506	415	510
6	12	35	256	418	564	847	611	142	183	81	85	159	101	170	173	155
7	13	16	207	314	461	889	664	28	90	31	39	56	31	59	61	69
8	11	24	133	195	397	743	575	12	39	9	12	16	7	14	23	21
9	4	7	32	32	144	223	136	4	10	5	2	2	3	9	8	13
10	12	5	29	26	87	144	75	2	14	8	8	5	7	14	11	12
11	3	1	17	12	33	45	21	1	7	3	5	6	15	5	10	12
12	1	0	4	5	8	13	1	1	3	1	2	1	3	4	5	11
13	1	1	7	4	20	18	12	1	4	0	1	2	2	3	1	15
14	0	0	2	6	17	21	2	1	0	0	2	3	1	4	7	3
15	1	1	4	2	12	24	7	5	3	2	4	2	2	0	9	3
16	1	0	1	4	8	16	10	16	19	2	4	3	1	4	15	9
Total	137	1,057	2,059	2,946	3,510	4,452	4,138	4,023	6,688	12,838	14,268	23,102	21,150	23,151	28,998	31,206

continued

Appendix E.2. (page 2 of 2) Right bank Anvik River corrected sonar estimates by sector and day, 22 June - 24 July, 1998.

Right Bank Sector	8-Jul	9-Jul[b]	10-Jul	11-Jul[c]	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul[d]
1	2,825	692		8,240	15,265	8,423	4,486	2,888	2,857	3,579	2,100	1,118	843	421	414	219	96
2	5,757	5,789		2,349	9,987	14,555	8,092	6,453	7,596	8,499	7,349	8,460	6,773	3,886	4,622	3,091	1,200
3	3,213	3,391		51	691	2,621	2,095	2,569	5,062	3,669	2,312	6,610	6,867	3,978	4,977	3,903	1,503
4	1,220	704		2	112	588	635	995	3,048	1,655	701	3,155	4,171	2,495	3,843	3,819	1,818
5	706	111		0	47	76	110	189	583	247	136	701	798	511	888	992	497
6	445	52		0	20	64	101	180	463	202	69	463	599	347	434	733	350
7	298	12		0	10	42	82	106	277	72	33	230	291	156	199	282	109
8	85	9		0	6	17	26	70	117	30	15	76	110	69	80	149	48
9	20	17		0	1	10	6	10	33	8	6	18	38	33	30	72	27
10	41	35		0	2	14	17	19	77	13	5	20	56	64	105	132	35
11	12	18		0	3	9	11	13	28	13	2	11	49	30	53	70	32
12	10	10		0	5	4	6	7	23	11	4	10	17	44	31	55	20
13	3	1		0	3	8	12	17	51	32	14	15	20	59	38	63	19
14	4	0		0	2	11	12	13	48	21	44	8	7	31	24	49	18
15	6	1		0	0	11	10	13	25	36	24	10	37	21	20	24	18
16	8	0		0	3	22	12	37	60	37	57	12	37	24	12	43	17
Total	14,653	10,839		10,643	26,158	26,474	15,710	13,579	20,347	18,125	12,871	20,914	20,714	12,170	15,773	13,695	5,805

a Right bank sonar counts began at 00:00 on 22 June.

b Right bank sonar counts terminated at 19:00 on 9 July due to flooding.

c Right bank sonar counts resumed at 13:00 on 11 July.

d Right bank sonar counts terminated at 12:30 on 24 July.

Appendix E.3. Right bank Anvik River corrected sonar estimates by sector and day, 27 June - 28 July, 1999.

Right Bank Sector	27-Jun[a]	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul	7-Jul	8-Jul	9-Jul	10-Jul	11-Jul	12-Jul
1	2	4	113	333	2,012	2,405	1,175	2,116	1,312	470	340	88	419	1,765	1,809	1,494
2	11	53	254	570	2,738	3,435	2,307	4,057	2,417	1,335	870	389	1,180	4,794	3,888	3,196
3	1	19	262	531	1,969	2,035	2,990	4,017	3,196	1,915	2,494	1,992	2,320	3,363	1,132	873
4	12	20	440	677	1,202	1,013	2,796	3,741	3,203	2,506	4,014	4,156	3,398	2,837	469	434
5	17	53	154	530	590	339	1,302	1,718	1,604	1,383	3,005	2,914	2,055	903	163	205
6	9	40	111	205	345	196	839	1,239	1,023	1,065	2,659	2,161	1,233	283	202	173
7	4	31	74	66	207	115	508	674	486	708	1,633	1,116	503	196	134	194
8	3	9	13	12	56	13	85	78	78	99	232	102	78	89	93	209
9	0	0	3	1	34	20	59	52	585	83	152	88	69	159	140	129
10	6	0	6	1	244	541	313	137	3,710	285	741	371	157	208	167	92
11	1	0	0	34	26	8	219	53	493	81	76	45	38	61	116	53
12	4	2	34	3	56	238	1,214	166	1,208	21	369	161	42	49	57	37
13	1	0	2	8	32	38	17	2	7	18	20	11	13	198	45	32
14	3	1	5	4	5	10	9	5	10	41	1	9	13	33	84	20
15	6	2	4	9	4	1	12	0	19	20	12	6	5	21	50	29
16	3	4	1	12	30	92	43	1	9	37	3	14	34	27	106	46
Total	83	238	1,477	2,997	9,551	10,499	13,889	18,055	19,358	10,067	16,621	13,625	11,558	14,988	8,654	7,218

continued

Appendix E.3. (page 2 of 2) Right bank Anvik River corrected sonar estimates by sector and day, 27 June - 28 July, 1999.

Right Bank Sector	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul	28-Jul[b]
1	1,744	912	946	1,383	1,307	1,158	945	472	1,662	2,493	1,983	538	353	145	195	186
2	4,014	2,202	4,597	5,744	5,122	5,298	4,419	4,577	4,116	2,198	2,327	1,358	700	599	540	585
3	1,109	2,215	1,603	1,966	2,112	1,801	2,263	2,205	1,911	716	874	943	620	339	683	472
4	376	1,056	767	1,569	1,612	1,183	1,559	1,339	1,362	509	485	580	391	177	357	158
5	140	330	188	571	471	307	434	420	666	251	457	558	479	178	176	57
6	115	181	112	226	200	145	178	202	252	94	172	252	180	85	58	38
7	105	185	110	323	232	216	219	282	200	61	81	124	92	58	22	28
8	45	256	89	193	442	74	180	212	173	39	99	102	152	61	175	56
9	73	117	146	142	122	84	83	235	76	39	90	104	105	39	15	31
10	148	101	94	192	90	86	81	86	78	44	105	138	100	33	11	8
11	44	61	45	78	66	57	34	49	43	22	27	54	100	37	90	10
12	52	335	31	46	40	58	130	85	10	13	9	30	19	13	2	2
13	35	91	33	84	33	18	126	23	1	14	14	49	11	20	10	41
14	85	121	132	30	40	40	18	33	2	22	2	16	11	4	10	48
15	46	18	129	46	26	43	70	11	10	37	5	22	8	6	3	4
16	96	171	198	34	37	72	57	40	3	10	9	12	12	3	1	1
Total	8,228	8,353	9,222	12,627	11,953	10,642	10,798	10,272	10,565	6,560	6,740	4,880	3,331	1,798	2,348	1,728

a Right bank sonar counting began at 00:00 on 27 June.

b Right bank sonar counting terminated at 24:00 on 28 July.

APPENDIX F: ANVIK RIVER LEFT BANK SPATIAL SONAR ESTIMATE DATA

Appendix F.1. Left bank Anvik River corrected sonar estimates by sector and day, 19 June - 24 July, 1997

Left Bank Sector	9-Jun[a]	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul
17	0	0	2	0	7	16	17	13	0	0	0	0	0	0	0	0	0	0
18	0	1	3	0	36	22	26	11	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	55	67	30	23	2	0	0	0	0	0	3	0	0	0
20	0	0	0	0	104	74	73	54	1	1	3	2	3	1	14	2	0	2
21	0	0	0	0	131	259	311	181	25	12	9	9	9	12	19	12	8	5
22	0	1	7	0	38	186	291	165	41	21	17	17	14	15	12	16	14	10
23	0	1	9	0	87	604	666	309	80	47	27	33	30	38	39	35	28	23
24	0	0	0	0	428	215	177	61	40	34	24	20	23	27	40	45	35	34
25	0	5	12	12	131	199	178	46	11	4	7	1	3	9	8	4	10	2
26	2	17	23	8	203	411	546	164	43	12	33	24	11	29	35	25	12	16
27	6	9	14	1	316	632	665	210	128	115	120	98	71	140	120	96	83	55
28	10	2	18	12	799	1,567	717	246	240	385	475	479	426	697	530	561	495	432
29	3	6	39	24	1,189	4,229	2,736	547	1,062	2,418	3,877	3,467	4,576	5,113	4,225	4,481	4,398	3,968
30	3	1	51	15	2,037	5,780	5,839	634	2,542	4,961	10,706	7,946	10,023	7,469	6,960	6,917	5,770	4,361
31	0	1	37	13	2,097	3,511	4,336	402	2,735	5,192	10,405	8,298	7,153	4,857	5,543	4,512	4,361	1,598
32	0	0	6	2	1,802	2,212	1,888	204	3,481	5,879	5,769	2,622	2,941	1,484	1,657	1,349	1,537	458
Total	24	44	221	87	9,461	19,984	18,494	3,271	10,433	19,079	31,472	23,018	25,284	19,892	19,204	18,053	16,750	10,963

continued

Appendix F.1. (page 2 of 2) Left bank Anvik River corrected sonar estimates by sector and day, 19 June - 24 July, 1997.

Left Bank Sector	7-Jul	8-Jul	9-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul[a]
17	8	0	44	25	22	32	38	34	44	35	43	53	141	96	29	5	10	1
18	2	2	17	48	32	41	17	30	42	45	37	51	82	106	16	5	10	2
19	0	0	26	16	24	20	13	27	25	25	26	27	63	51	9	11	12	9
20	1	16	22	33	29	14	23	24	43	27	43	46	112	114	12	16	20	26
21	5	17	26	44	32	27	22	18	33	22	34	93	88	68	24	25	22	24
22	7	40	32	48	46	33	33	30	62	65	73	83	141	131	103	91	59	25
23	25	60	106	131	97	49	43	58	101	118	159	123	112	90	179	136	123	130
24	47	136	92	56	29	18	18	23	50	70	56	84	42	43	59	80	14	119
25	2	9	70	146	93	35	50	79	118	87	98	172	170	139	294	29	23	28
26	10	31	113	418	187	109	72	151	282	274	312	368	234	309	743	70	30	145
27	109	189	446	1,424	605	212	215	514	807	823	989	433	111	91	323	132	53	90
28	630	1,219	1,080	1,302	920	329	253	663	1,285	1,566	1,612	714	202	103	121	126	148	82
29	4,822	5,026	3,221	1,923	1,901	1,076	606	1,231	2,614	4,250	2,412	1,237	415	239	332	450	227	228
30	7,139	4,338	1,602	1,094	1,511	935	336	484	1,199	1,670	1,130	765	475	431	402	872	447	532
31	2,910	1,121	617	794	1,359	972	273	226	691	624	352	2,724	3,668	2,262	2,206	2,885	1,751	1,489
32	803	432	98	99	155	127	19	27	89	54	32	1,363	2,386	1,601	915	686	373	485
Total	16,522	12,636	7,612	7,600	7,041	4,030	2,031	3,617	7,484	9,757	7,408	8,337	8,443	5,874	5,764	5,619	3,321	3,415

a Left bank sonar counting began at 18:00 on 9 June.

c Left bank sonar counting terminated at 24:00 on 24 July.

Appendix F.2. Left bank Anvik River corrected sonar estimates by sector and day, 22 June - 24 July, 1998.

Left Bank Sector	22-Jun	23-Jun	24-Jun	5-Jun[a]	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul	7-Jul
17				2	6	0	1	0	3	0	0	0	0	0	0	0
18				0	0	0	0	0	0	0	0	0	0	0	0	0
19				0	1	0	1	1	0	1	0	1	0	0	0	0
20				0	0	1	1	5	0	1	0	0	0	0	0	0
21				0	0	1	11	12	0	0	0	0	0	0	0	0
22				0	4	9	24	20	0	0	0	0	0	0	0	0
23				0	13	16	28	15	0	1	0	0	0	0	0	0
24				1	8	6	24	19	0	0	0	0	0	0	0	0
25				10	18	16	54	44	16	20	0	0	0	1	1	1
26				11	51	23	43	63	102	61	3	21	12	20	32	29
27				55	41	20	65	146	177	143	68	185	168	209	399	190
28				18	55	35	33	120	230	320	99	200	218	244	633	434
29				34	33	34	31	224	405	488	142	271	334	382	669	730
30				10	19	6	40	166	304	487	132	333	400	491	1,228	925
31				17	6	2	0	14	60	141	136	328	361	529	839	655
32				17	2	0	0	12	100	25	20	190	535	380	1,462	1,761
Total				175	256	169	357	861	1,396	1,687	600	1,529	2,028	2,256	5,263	4,724

continued

Appendix F.2. (page 2 of 2) Left bank Anvik River corrected sonar estimates by sector and day, 22 June - 24 July, 1998.

Left Bank Sector	8-Jul	9-Jul[b]	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul[c]	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul[d]
17	1							1	6	0	0	0	0	0	0	0	0
18	1							1	10	0	0	0	0	0	0	0	0
19	0							1	10	4	0	0	0	0	0	0	0
20	0							1	14	8	0	0	0	0	0	0	0
21	0							1	6	12	0	0	0	0	0	1	0
22	2							1	1	11	0	0	0	0	0	0	0
23	4							2	4	27	3	11	2	10	13	0	1
24	5							0	5	25	10	38	14	39	35	12	0
25	37							38	78	132	230	237	195	398	213	140	40
26	20							97	336	431	607	578	638	1,011	607	620	223
27	67							483	1,194	1,721	2,414	2,525	3,163	2,899	1,772	1,447	566
28	145							447	968	1,194	1,694	2,848	2,786	3,258	2,276	1,256	450
29	187							610	1,343	1,717	1,646	2,239	2,307	1,545	2,644	1,486	601
30	194							886	2,431	1,882	1,750	2,538	2,759	995	4,078	1,413	498
31	380							1,542	3,459	1,935	1,032	297	113	63	1,867	327	142
32	1,279							512	806	489	329	394	499	380	737	858	12
Total	2,321							4,622	10,671	9,590	9,714	11,705	12,476	10,598	14,241	7,560	2,533

a Left bank sonar counts began at 11:45 on 25 June.

b Left bank sonar counts terminated at 00:00 on 9 July due to flooding.

c Left bank sonar counts resumed at 09:00 on 15 July.

d Left bank sonar counts terminated at 11:30 on 24 July.

Appendix F.3. Left bank Anvik River corrected sonar estimates by sector and day, 27 June - 28 July, 1999.

Left Bank Sector	27-Jun[a]	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul	7-Jul	8-Jul	9-Jul	10-Jul	11-Jul	12-Jul
17	0	10	2	33	33	115	472	261	8	131	175	217	110	175	199	555
18	0	0	1	6	35	52	371	338	8	67	119	80	50	117	93	172
19	0	1	5	13	62	103	225	6	1	68	110	54	27	53	21	43
20	0	2	8	17	91	92	138	5	1	32	62	33	32	18	10	48
21	0	0	7	21	39	44	91	1	0	22	38	23	19	17	10	30
22	0	0	2	17	32	62	57	2	0	37	29	18	12	15	7	25
23	0	0	0	6	9	23	14	11	11	26	12	15	15	10	11	17
24	0	0	3	7	18	16	43	38	50	21	12	6	8	6	4	14
25	0	2	2	18	38	62	79	273	272	87	57	33	57	80	56	46
26	0	5	10	32	65	53	77	264	305	626	382	283	292	378	295	238
27	0	6	9	36	48	68	87	231	419	1,687	1,052	966	976	1,324	937	778
28	0	1	8	10	27	25	62	169	658	2,356	2,264	3,091	2,539	3,907	2,622	1,518
29	0	2	7	4	6	23	100	196	1,711	3,327	3,128	4,379	1,787	3,896	3,580	1,819
30	0	3	2	0	5	3	69	194	1,928	2,347	2,530	1,423	1,336	1,183	1,557	786
31	1	4	2	0	0	3	77	290	2,885	3,906	4,207	2,027	1,812	2,382	2,771	2,044
32	1	0	1	0	0	0	52	383	3,162	3,268	4,248	1,834	1,014	1,394	2,190	1,451
Total	2	36	69	220	507	744	2,013	2,663	11,419	18,008	18,424	14,481	10,086	14,956	14,362	9,583

continued

Appendix F.3. (page 2 of 2) Left bank Anvik River corrected sonar estimates by sector and day, 27 June - 28 July, 1999.

Left Bank Sector	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul	28-Jul[b]
17	363	462	664	926	917	1,019	1,209	837	388	380	531	422	284	209	62	19
18	202	293	539	542	549	654	687	436	130	144	279	207	97	60	31	19
19	73	96	29	52	35	38	63	47	63	55	26	43	27	18	12	6
20	31	26	20	20	16	16	21	39	71	59	25	40	23	18	4	12
21	15	6	6	16	5	6	16	50	49	69	69	33	19	22	7	6
22	9	3	4	14	6	6	6	19	34	43	22	28	8	6	3	5
23	15	8	8	9	4	10	10	20	47	33	17	7	8	9	4	2
24	6	9	8	4	1	3	5	11	19	16	15	2	3	10	2	4
25	92	64	57	65	52	52	75	65	81	45	27	18	20	9	7	4
26	357	358	236	242	177	225	255	192	149	115	76	75	50	16	22	8
27	898	609	355	406	353	391	393	267	199	144	118	105	103	42	27	18
28	1,118	1,364	920	808	364	283	480	267	108	101	89	115	90	30	25	5
29	1,454	1,323	690	1,133	339	285	558	274	143	119	121	73	171	54	46	15
30	586	287	106	288	97	126	116	177	210	99	114	71	89	62	44	29
31	1,243	282	108	242	97	190	171	292	542	326	255	111	166	84	61	43
32	657	164	36	129	46	74	226	133	295	158	189	53	100	22	23	16
Total	7,119	5,352	3,787	4,895	3,058	3,378	4,291	3,126	2,529	1,906	1,971	1,402	1,256	671	380	211

a Left bank sonar counting began at 00:00 on 27 June.

b Left bank sonar counting terminated at 18:30 on 28 July.

APPENDIX G: ANVIK RIVER BEACH SEINE AGE-SEX-LENGTH SAMPLING DATA

Appendix G.1. Anvik River beach seine catch by species, sex, day, and passage quartile, and the number of chum salmon sampled for age, sex, length information, by sex and day, 1997.

	Chum Salmon						Other Fish				
	Number Captured			Number Sampled			Number Captured				
Date	Male	Female	Total	Male	Female	Total	Pink Salmon	Grayling	Whitefish	Char	Other
26-Jun	58	52	110	22	18	40	0	4	0	0	2 Suckers
28-Jun	3	1	4	3	1	4	0	4	1	0	
30-Jun	39	38	77	34	35	69	0	9	2	0	
2-Jul	39	33	72	37	31	68	0	9	6	0	
5-Jul	23	25	48	14	21	35	0	19	6	0	
6-Jul	45	32	77	41	32	73	0	7	6	1	1 Chinook salmon
7-Jul	19	21	40	18	20	38	0	2	3	0	2 Chinook salmon
8-Jul	10	25	35	10	25	35	0	0	2	0	1 Sucker, 1 Pike
10-Jul	52	114	166	32	48	80	0	2	8	0	
12-Jul	21	63	84	19	61	80	0	12	4	0	
15-Jul	12	21	33	12	18	30	0	7	6	0	
16-Jul	16	18	34	15	17	32	0	3	4	0	
18-Jul	28	56	84	11	29	40	0	1	8	0	
24-Jul	Data not available			8	12	20	Data not available				
Stratum Totals (using 1997 quartile passage dates)											
19 June - 28 June	61	53	114	25	19	44	0	8	1	0	
Percent	54%	46%		57%	43%						
29 June - 3 July	78	71	149	71	66	137	0	18	8	0	
Percent	52%	48%		52%	48%						
4 July - 10 July	149	217	366	115	146	261	0	30	25	1	
Percent	41%	59%		44%	56%						
11 July - 24 July	77	158	235	65	137	202	0	23	22	0	
Percent	33%	67%		32%	68%						
Season Totals	365	499	864	276	368	644	0	79	56	1	
Percent	42%	58%		43%	57%						

Appendix G.2. Anvik River beach seine catch by species, sex, day, and passage quartile, and the number of chum salmon sampled for age, sex, length information, by sex and day, 1998.

	Chum Salmon						Other Fish				
	Number Captured			Number Sampled			Number Captured				
Date	Male	Female	Total	Male	Female	Total	Pink Salmon	Grayling	Whitefish	Char	Other
26-Jun	13	6	19	13	6	19	0	2			
28-Jun	2	4	6	2	4	6	0	9	11	2	7 Suckers
29-Jun	0	1	1	0	1	1	0	7	7	3	
30-Jun	11	6	17	11	6	17	0	6	34	6	1 Pike
1-Jul	105	114	219	53	59	112	0	4	5	0	1 Sucker
6-Jul	34	36	70	34	36	70	0	20	0	1	1 Chinook salmon (jack)
13-Jul	37	43	80	34	41	75	14	23	7	0	
14-Jul	11	12	23	11	11	22	19	12	0	0	1 Pike
15-Jul	87	128	215	16	64	80	27	19	10	1	
17-Jul	17	15	32	18	14	32	41	25	5	1	
18-Jul	14	30	44	14	26	40	66	9	5	1	
19-Jul	15	30	45	15	31	46	58	19	12	0	
20-Jul	38	139	177	8	37	45	31	7	8	0	
Stratum Totals (using 1998 quartile passage dates)											
22 June - 5 July	131	131	262	79	76	155	0	28	57	11	
Percent	50%	50%		51%	49%						
6 July - 9 July	34	36	70	34	36	70	0	20	0	1	
Percent	49%	51%		49%	51%						
10 July - 14 July	48	55	103	45	52	97	33	35	7	0	
Percent	47%	53%		46%	54%						
15 July - 24 July	171	342	513	71	172	243	223	79	40	3	
Percent	33%	67%		29%	71%						
Season Totals	384	564	948	229	336	565	256	162	104	15	
Percent	41%	59%		41%	59%						

Appendix G.3. Anvik River beach seine catch by species, sex, day, and passage quartile, and the number of chum salmon sampled for age, sex, length information, by sex and day, 1999.

	Chum Salmon						Other Fish				
	Number Captured [a]			Number Sampled			Number Captured				
Date	Male	Female	Total	Male	Female	Total	Pink Salmon	Grayling	Whitefish	Char	Other
4-Jul	24	36	60	24	36	60					
5-Jul	29	38	67	29	38	67					
7-Jul	15	32	47	15	32	47					
8-Jul	38	25	63	38	25	63					1 Chinook salmon
9-Jul	22	31	53	22	31	53					3 Chinook salmon
11-Jul	27	40	67	27	40	67		1			1 Pike
12-Jul	34	39	73	34	39	73					1 Chinook salmon
13-Jul	9	14	23	9	14	23					
17-Jul	14	18	32	14	18	32					
18-Jul	25	64	89	25	64	89					
20-Jul	23	25	48	23	25	48					
Stratum Totals (using 1999 quartile passage dates)											
27 June - 6 July	53	74	127	53	74	127	0	0	0	0	
Percent	42%	58%		42%	58%						
7 July - 10 July	75	88	163	75	88	163	0	0	0	0	
Percent	46%	54%		46%	54%						
11 July - 16 July	70	93	163	70	93	163	0	1	0	0	
Percent	43%	57%		43%	57%						
17 July - 28 July	62	107	169	62	107	169	0	0	0	0	
Percent	37%	63%		37%	63%						
Season Totals	260	362	622	260	362	622	0	1	0	0	
Percent	42%	58%		42%	58%						

[a] Only the number of chum salmon sampled each day was recorded.

APPENDIX H: ANVIK RIVER HISTORIC ESCAPEMENT AGE AND SEX DATA

Appendix 11. Age and sex composition of Anvik River chum salmon escapement samples, 1972-1999.[a]

Year	Total Sample				Percent of Aged Scales[b]											
					Age 0.2			Age 0.3			Age 0.4			Age 0.5		
	Male (%)	Female (%)	Number of Fish	Number Aged	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	52.2	47.8	320	320	0.0	0.0	0.0	7.8	11.6	19.4	43.1	35.9	79.1	1.3	0.3	1.6
1973	33.8	66.2	783	783	1.4	4.7	6.1	26.1	51.2	77.3	6.3	10.1	16.3	0.1	0.1	0.3
1974	60.9	39.1	402	402	3.0	6.0	9.0	49.0	29.9	78.9	8.5	3.0	11.4	0.5	0.2	0.7
1975	46.2	53.8	584	584	0.7	2.9	3.6	43.3	49.3	92.6	2.2	1.5	3.8	0.0	0.0	0.0
1976	46.8	53.2	601	601	0.8	0.7	1.5	7.2	5.8	13.0	38.8	46.8	85.5	0.0	0.0	0.0
1977	32.4	67.6	589	589	3.4	18.8	22.2	27.3	45.8	73.2	1.2	2.5	3.7	0.5	0.3	0.8
1978	52.4	47.6	552	552	0.0	0.2	0.2	38.0	32.6	70.7	14.3	14.9	29.2	0.0	0.0	0.0
1979	47.2	52.8	579	579	0.3	2.1	2.4	26.6	33.3	59.9	19.9	17.1	37.0	0.3	0.3	0.7
1980	39.3	60.7	425	425	0.0	0.2	0.2	34.6	53.2	87.8	4.7	7.3	12.0	0.0	0.0	0.0
1981	45.3	54.7	333	333	0.0	0.0	0.0	14.7	20.1	34.8	29.7	34.5	64.3	0.9	0.0	0.9
1982	30.6	69.4	382	382	1.0	4.5	5.5	19.6	47.4	67.0	9.7	17.0	26.7	0.3	0.5	0.8
1983	43.5	56.5	421	421	0.0	1.0	1.0	23.5	33.7	57.2	19.7	21.4	41.1	0.2	0.5	0.7
1984	39.1	60.9	353	353	0.6	1.7	2.3	33.1	53.5	86.7	5.4	5.7	11.0	0.0	0.0	0.0
1985	44.2	55.8	527	527	0.0	2.1	2.1	32.6	42.7	75.3	11.2	11.0	22.2	0.4	0.0	0.4
1986	42.2	57.8	486	486	0.0	0.4	0.4	12.1	18.3	30.5	29.4	38.3	67.7	0.6	0.8	1.4
1987	34.9	65.1	545	545	0.0	1.8	1.8	22.9	43.7	66.6	10.3	18.3	28.6	1.7	1.3	2.9
1988	33.9	66.1	531	531	0.2	5.6	5.8	24.3	53.1	77.4	9.0	7.0	16.0	0.4	0.4	0.8
1989[c]	34.4	65.6	588	588	0.0	1.2	1.2	9.4	28.5	37.9	24.8	35.9	60.7	0.1	0.0	0.1
1990[c]	48.7	51.3	399	399	0.6	2.5	3.1	26.0	39.1	65.1	18.8	11.3	30.1	1.2	0.4	1.6
1991[c]	42.1	57.9	552	552	0.0	0.0	0.0	16.4	27.8	44.2	25.6	30.1	55.6	0.2	0.0	0.2
1992[c]	43.4	56.6	424	424	0.0	0.3	0.3	8.4	18.1	26.5	32.6	36.3	69.0	2.4	1.8	4.2
1993[c,d]	48.0	52.0	660	546	0.1	0.5	0.6	26.1	38.8	64.8	17.8	14.6	32.4	0.9	1.3	2.2
1994[c,d]	41.3	58.7	1,224	560	0.0	0.0	0.0	15.2	19.8	35.0	25.8	38.0	63.8	0.7	0.5	1.2
1995[c,d]	60.2	39.8	667	589	0.7	2.0	2.7	31.9	21.4	53.3	26.2	13.4	39.6	3.8	0.5	4.4
1996[c]	40.1	59.9	674	615	0.2	0.3	0.5	17.4	38.0	55.4	21.8	20.5	42.3	1.1	0.7	1.8
1997[c,d]	46.4	53.6	864	611	0.2	0.3	0.5	17.3	26.4	43.7	24.7	29.5	54.2	0.8	0.0	0.8
1998[c,d]	44.1	55.9	948	460	0.0	0.0	0.0	30.2	50.2	80.4	9.4	8.9	18.3	0.2	1.1	1.3
1999[c,d]	41.9	58.1	622	462	0.0	0.0	0.0	14.7	22.7	37.4	27.3	34.0	61.3	0.2	1.1	1.3
1972-1996 Median	43.4	56.6					1.1			62.4			34.7			0.8

[a] Samples collected by carcass survey 1972-1981, by beach seine 1983-1999, and by both methods combined in 1982.

[b] Sample percentages not weighted by time period or escapement counts.

[c] Sample percentages weighted by time period and escapement counts.

[d] Sex composition based on entire beach seine catch. Age composition based on aged scales.